THE ENGINEER

APRIL 22, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

B.S.P. pile hammers drive Britain's longest pre-stressed concrete piles

m.v. "GROSVENOR" showing the pendulum leaders swivelled sideways and raked for driving. Contractors: John Mowlem & Co. Ltd., London, S.W.1.

Two special 95ft. raking pile frames equipped with B. S. P. 8-ton and 10-ton single-acting hammers were used for driving vertical and raking cylindrical pre-stressed concrete bearing piles for the new Esso Marine Terminal at Milford Haven.

Mounted on the contractors' own vessels, each B. S. P. pile frame is designed to rake backwards to 1 in 3 and incorporates pendulum leaders capable of raking sideways independently to the same extent. The leaders may also be swivelled to face outwards or to either side as required.

The 27½in. diameter 143ft.-long concrete bearing piles, the longest of this type to be installed in Great Britain, were driven in 60ft. of water through 50ft. of silt, sand and gravel to hard bedrock.

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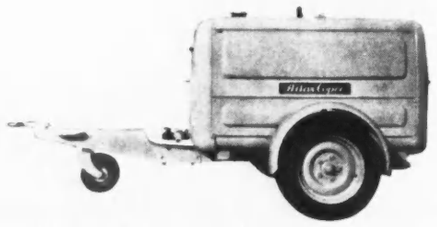
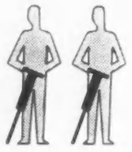
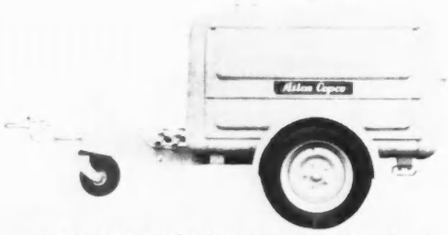
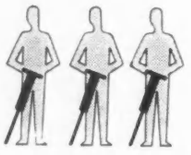




Weight 2,180 lb (990 kg) ★ 115 c.f.m. 3.2m³/m

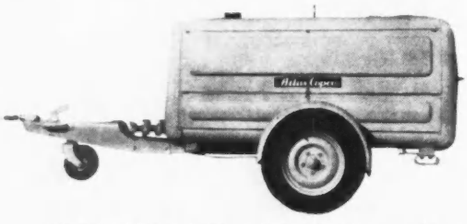
VT4

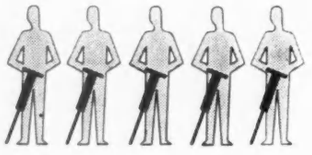




Weight 2,310 lb (1,050 kg) ★ 160 c.f.m. 4.5m³/m

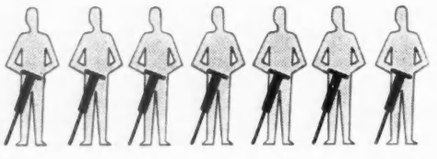
VT5





Weight 2,900 lb (1,315 kg) ★ 225 c.f.m. 6.4m³/m

VT6



Weight 3,590 lb (1,630 kg) ★ 315 c.f.m. 8.9m³/m

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THE ENGINEER

Established 1856

No. 5439 **APRIL 22, 1960** VOL. 209

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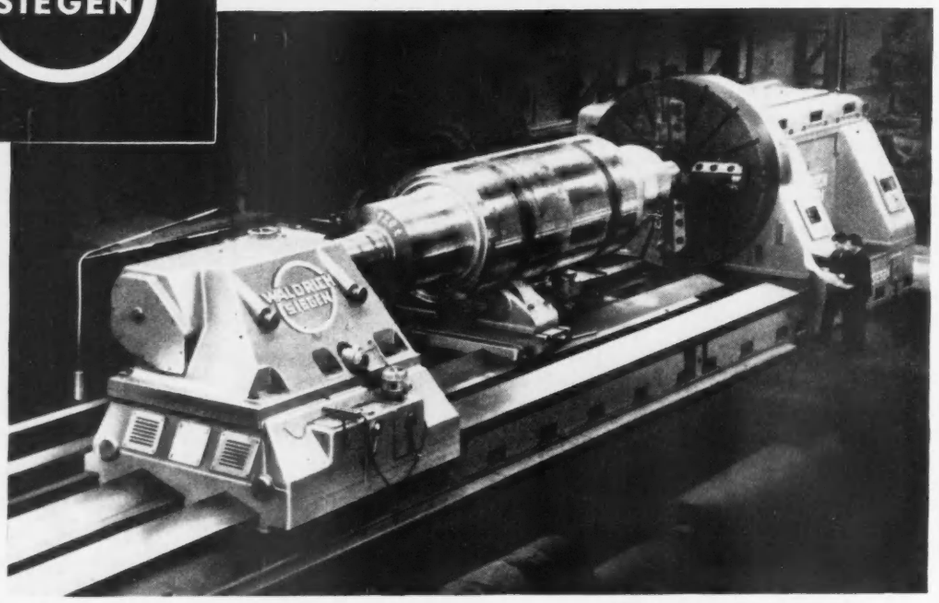

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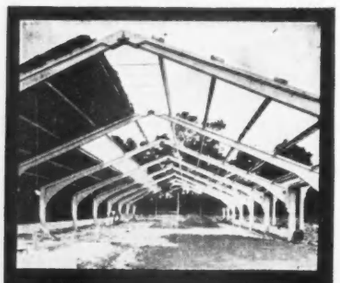

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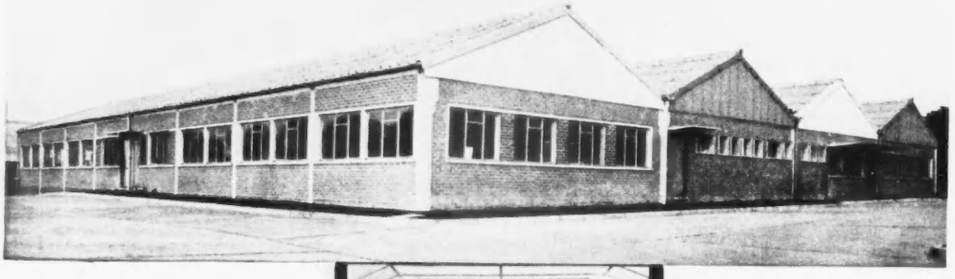

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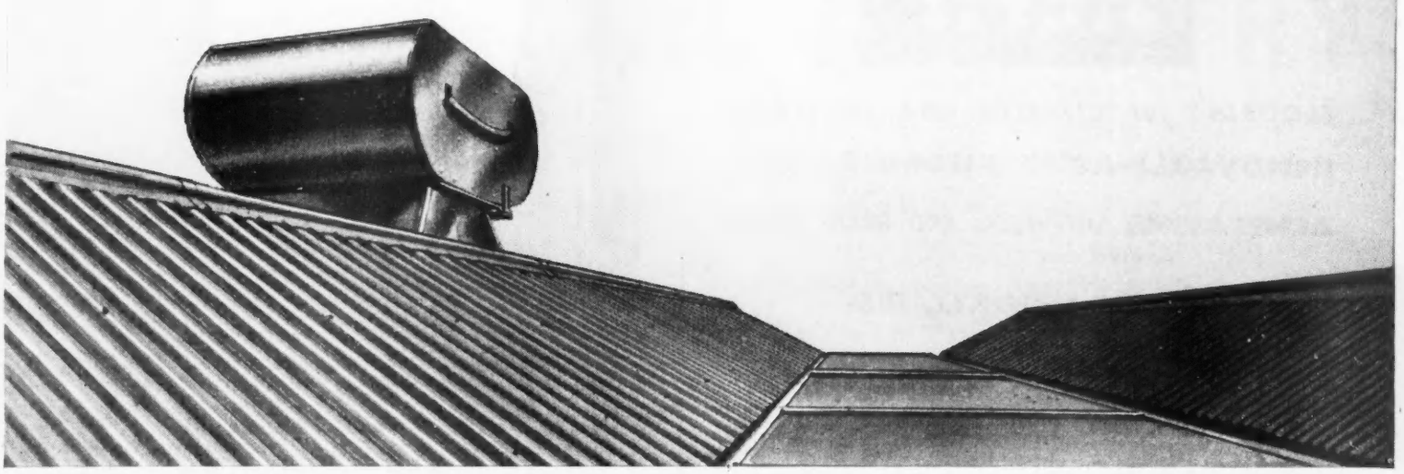

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bolts

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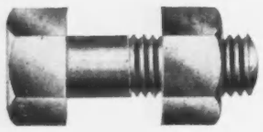

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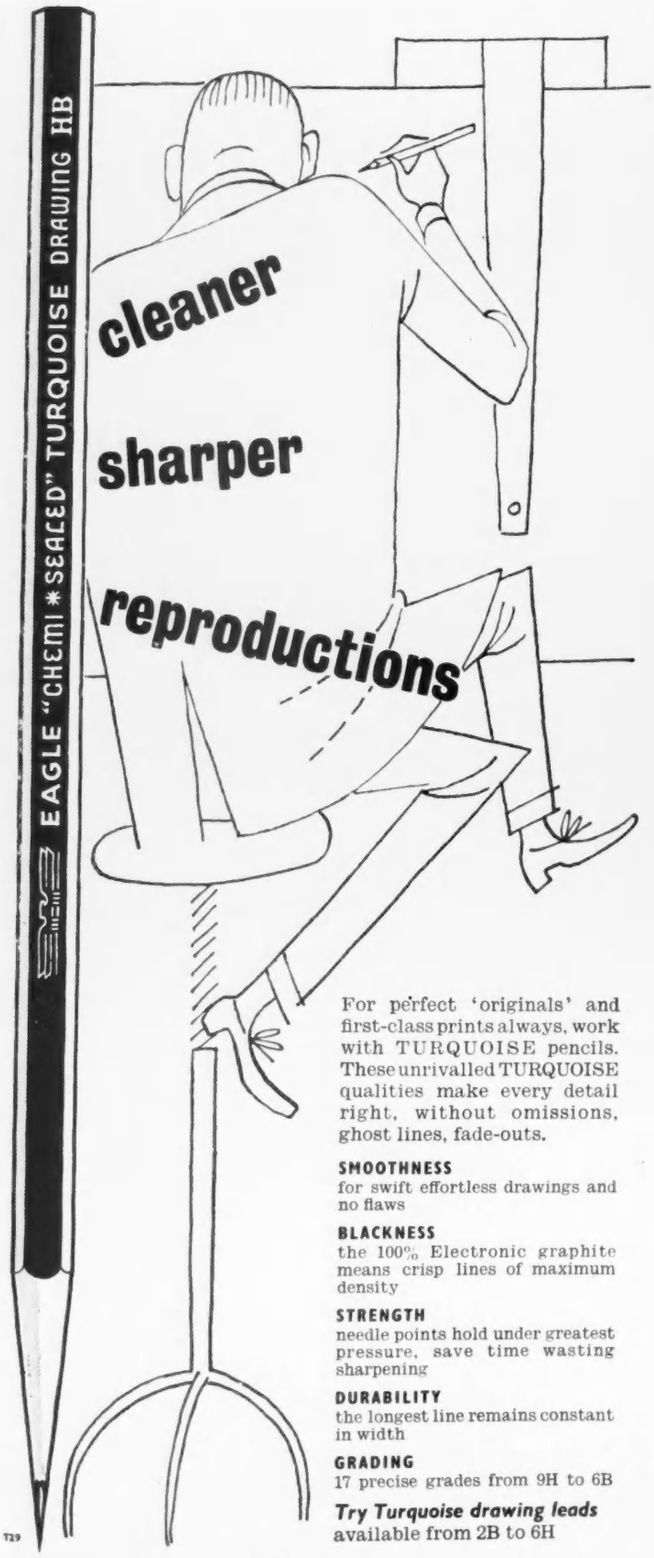

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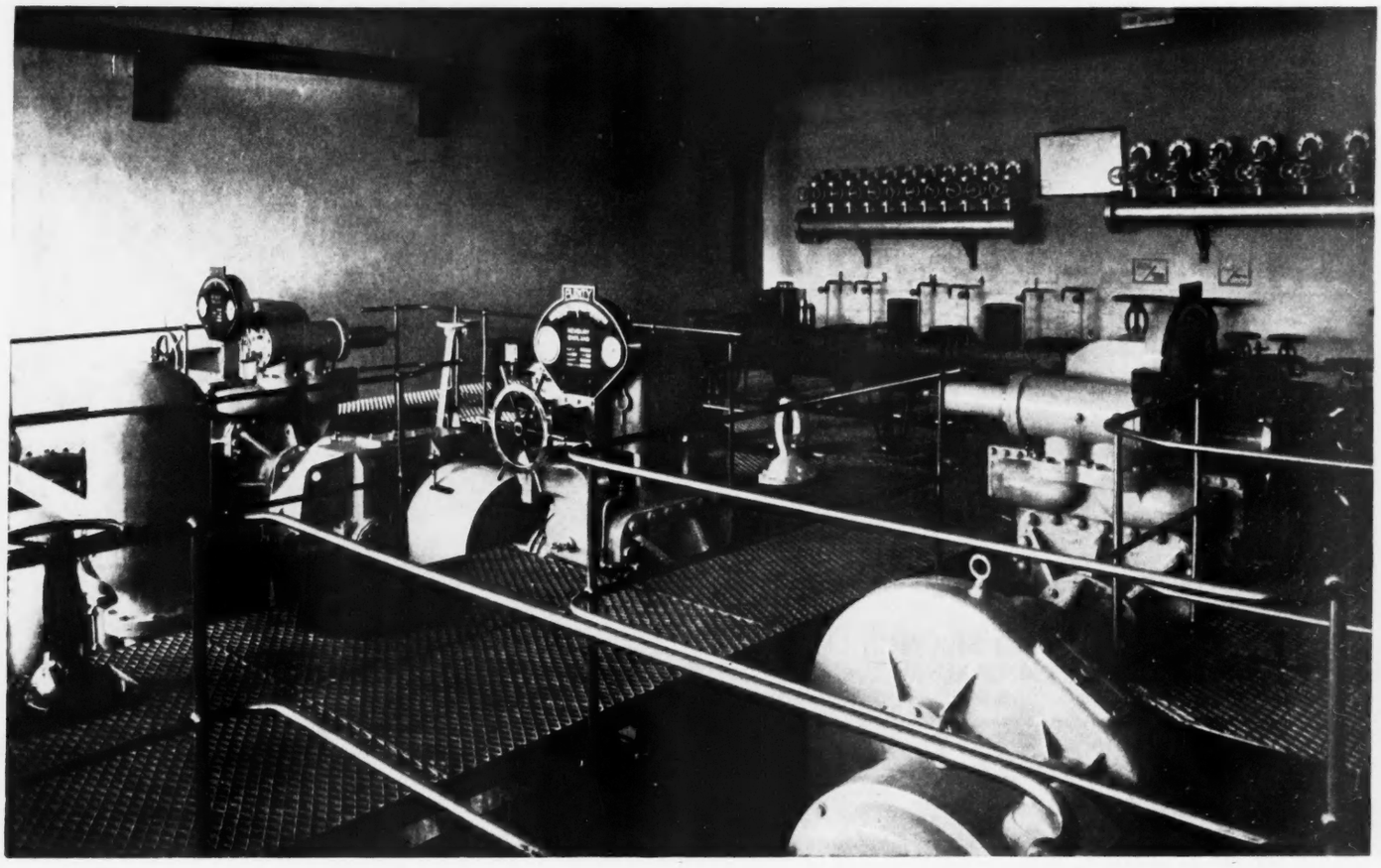

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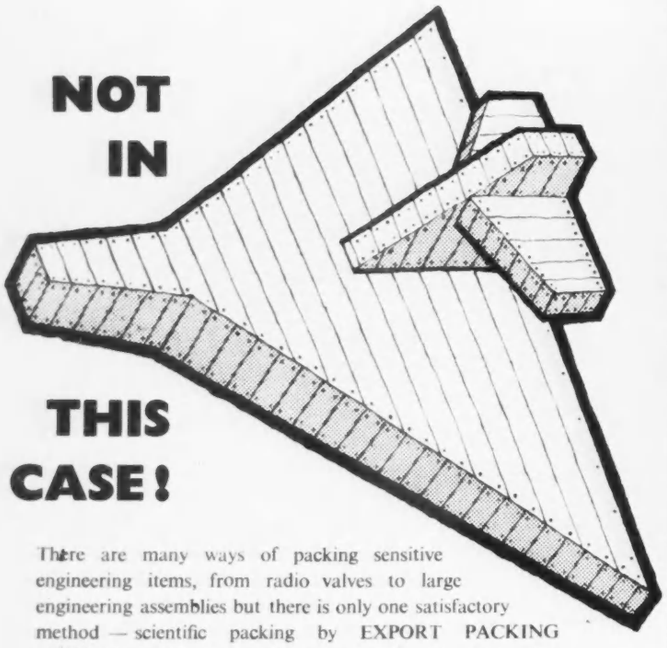

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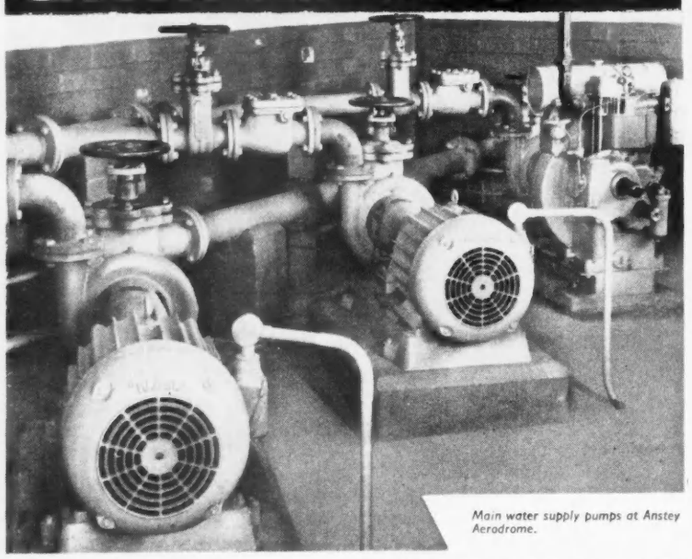

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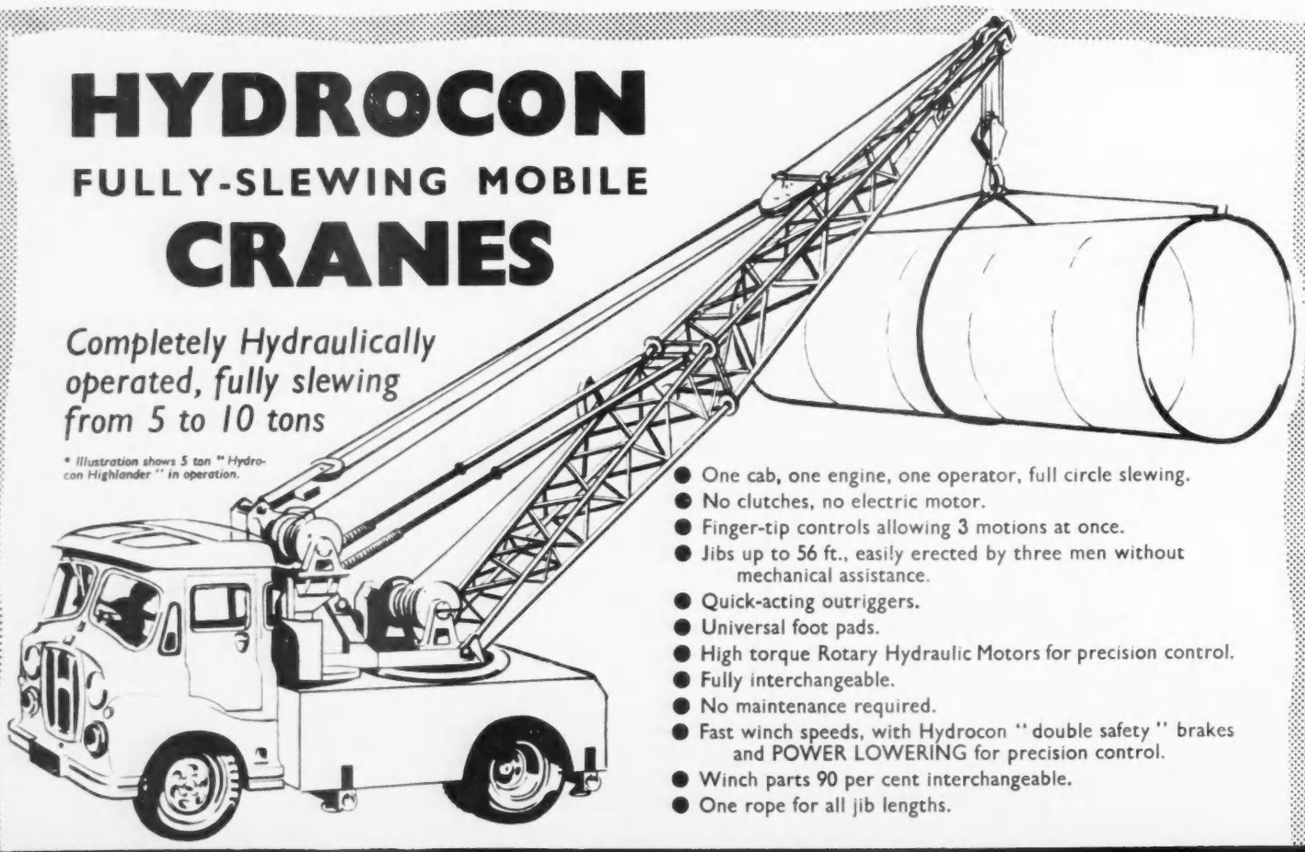

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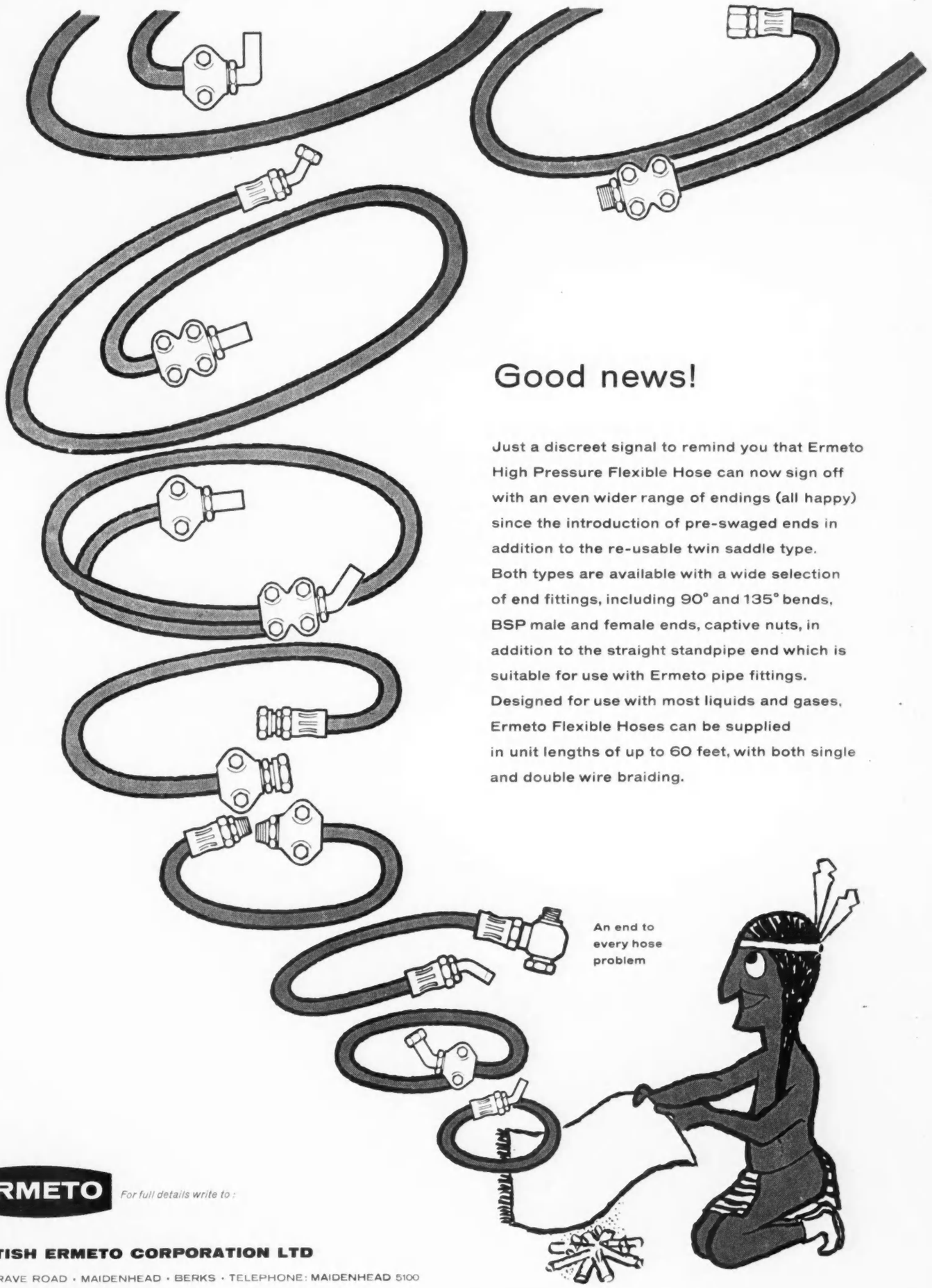

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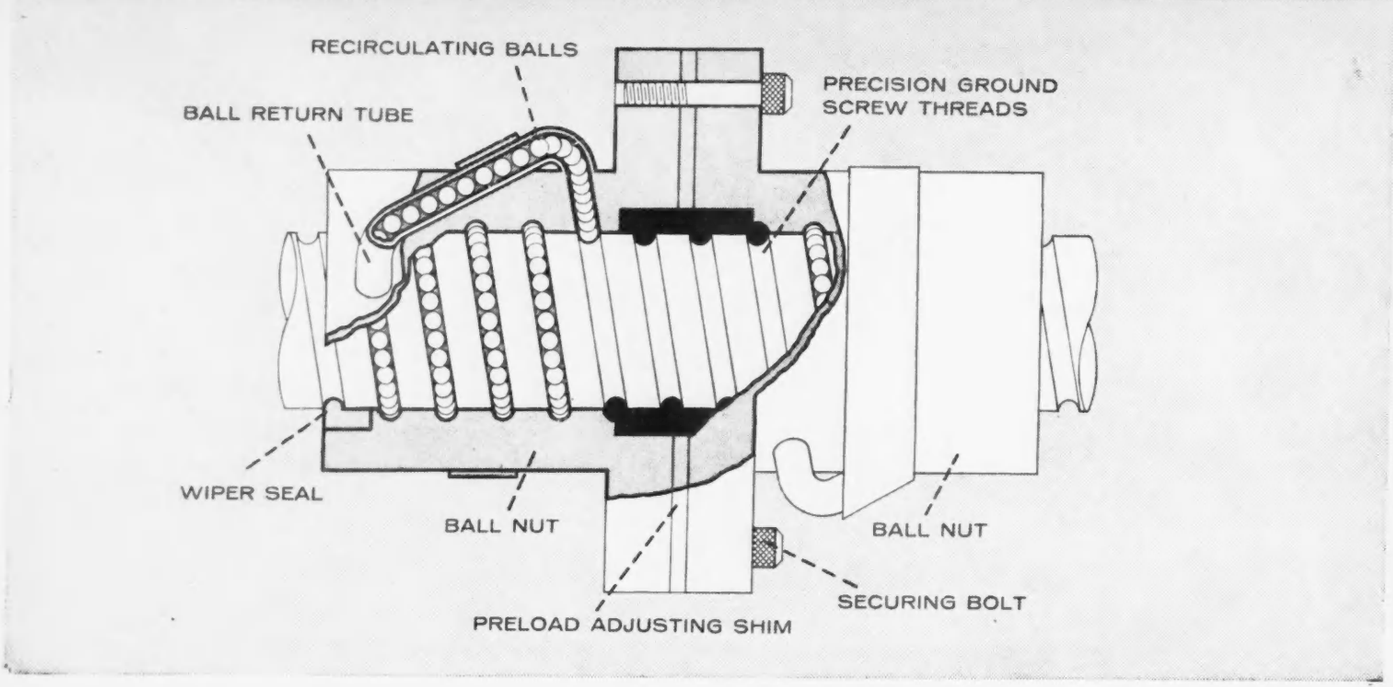

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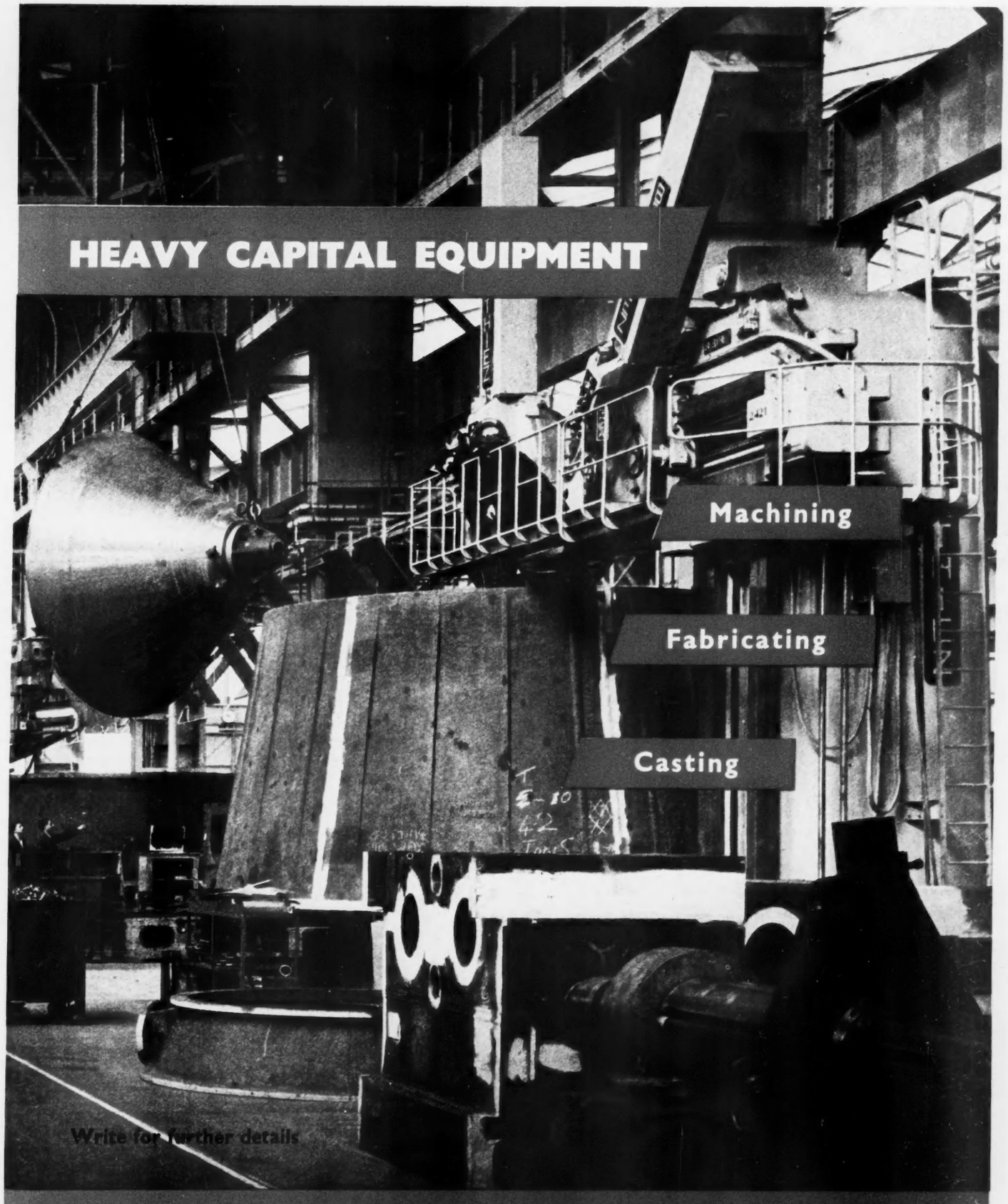

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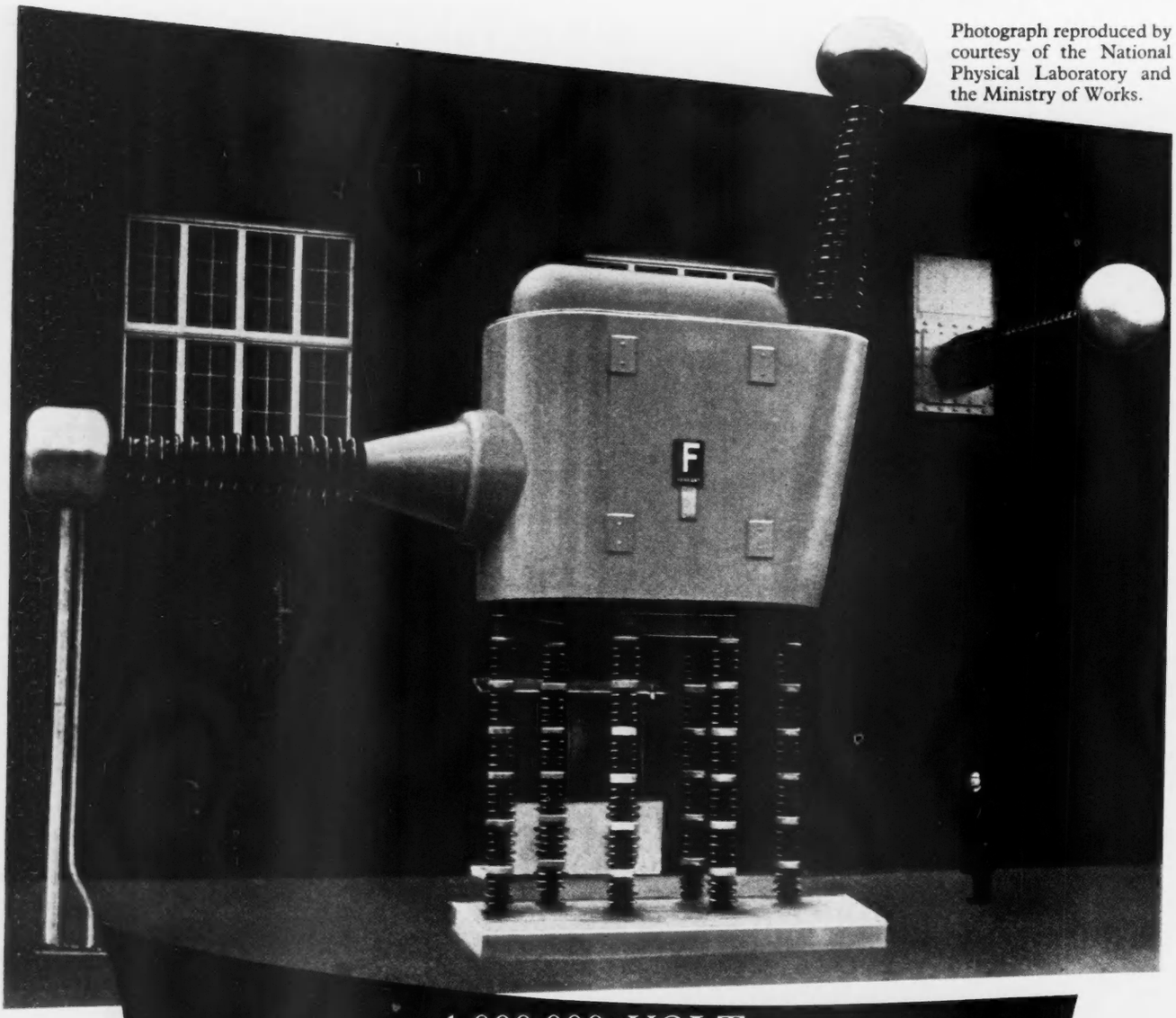

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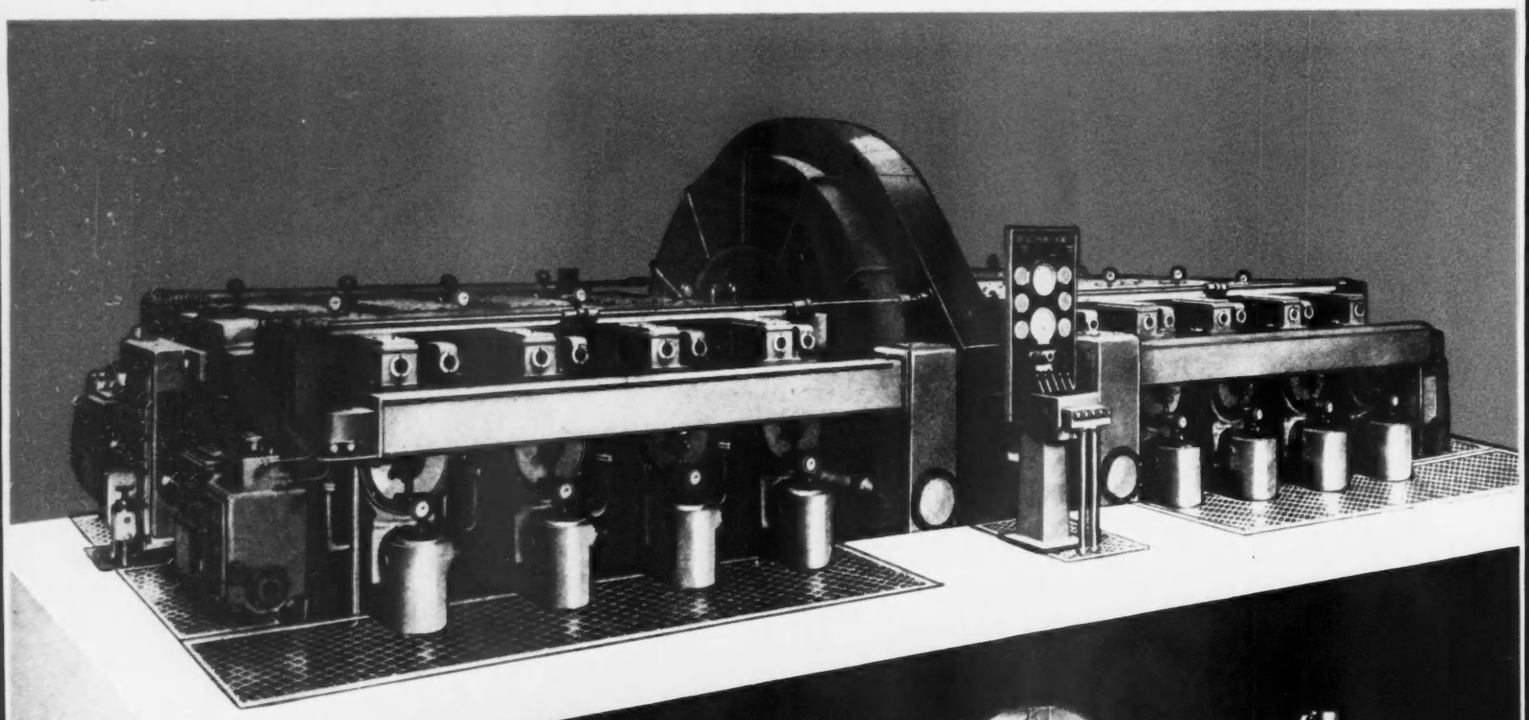

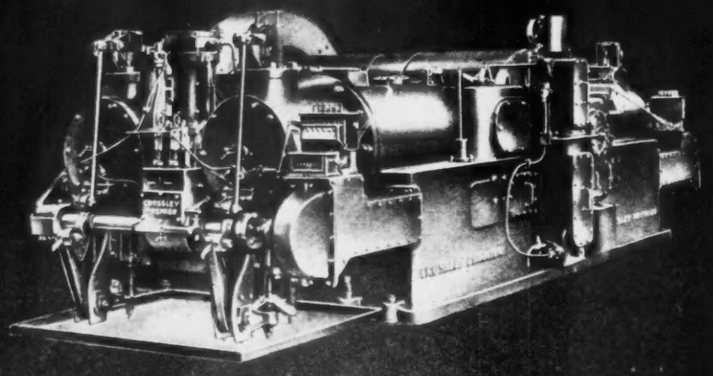

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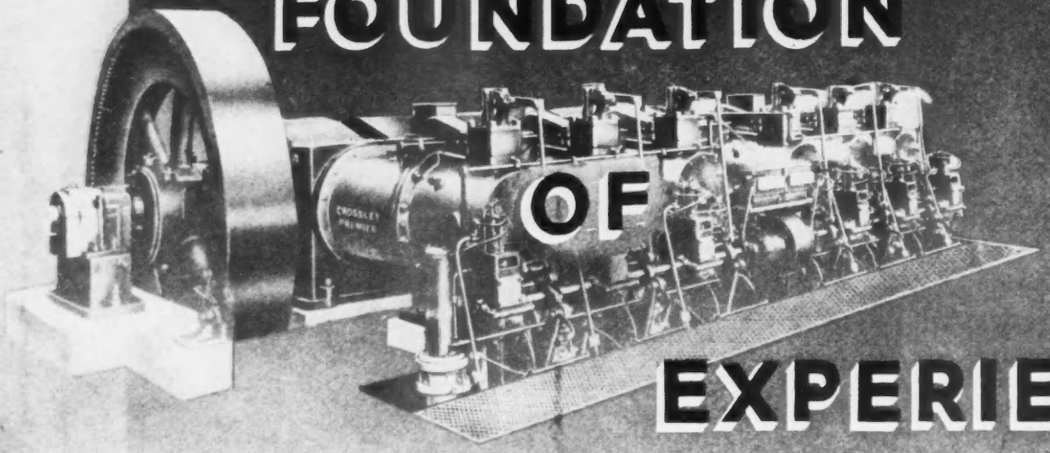

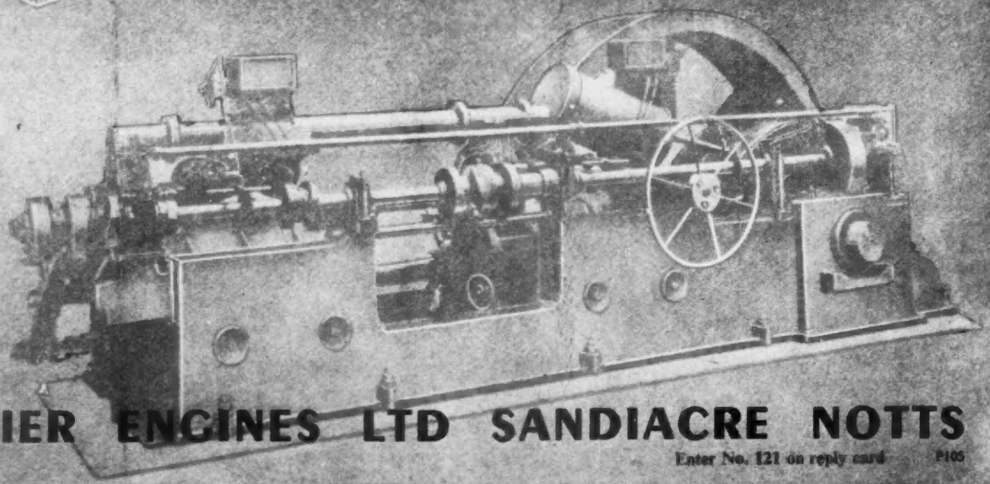

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GLACIER DQ

a bearing material in tube form from which you can machine your own dry bearings

MACHINABLE, MOULDABLE DQ

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PROPERTIES OF DQ

DQ dry bearing material, though neither quite as strong or quite as wear-resistant as DU, has, in itself and throughout, frictional and wear-resisting properties comparable with those of lubricated bearings, and it can be used at temperatures from —200° to +250°C. Absence of oil means that no contamination can occur with DQ, which operates even when totally immersed in liquid—often with improved performance—and is resistant to corrosion by many industrial liquids and gases, *including solvents.* It is tolerant of dirty surroundings. There are *no* static electricity phenomena associated with DQ, and it is entirely free from slipstick effects.

DQ SUCCESSES IN MANY FIELDS

Successful applications of DQ dry bearing material include:—Cold and hot service seals, pump bushes and thrust washers for industrial liquids and gases, including liquid oxygen and liquid nitrogen plant applications; mechanical movements for electronic computers and indicating and recording instruments; bushes etc. for hot water circulating pumps (submerged) and for compressors; textile machinery; aircraft controls and instruments; etc., etc.

Further new applications for DQ Dry Bearing Materials are waiting for designers who can take advantage of the properties of this very remarkable material.

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Glacier will be pleased to send you a free technical handbook on DU and DQ Dry Bearing Materials.

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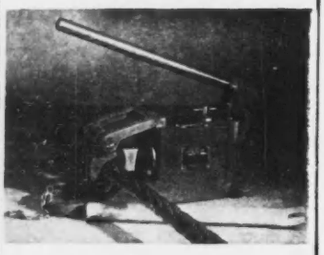

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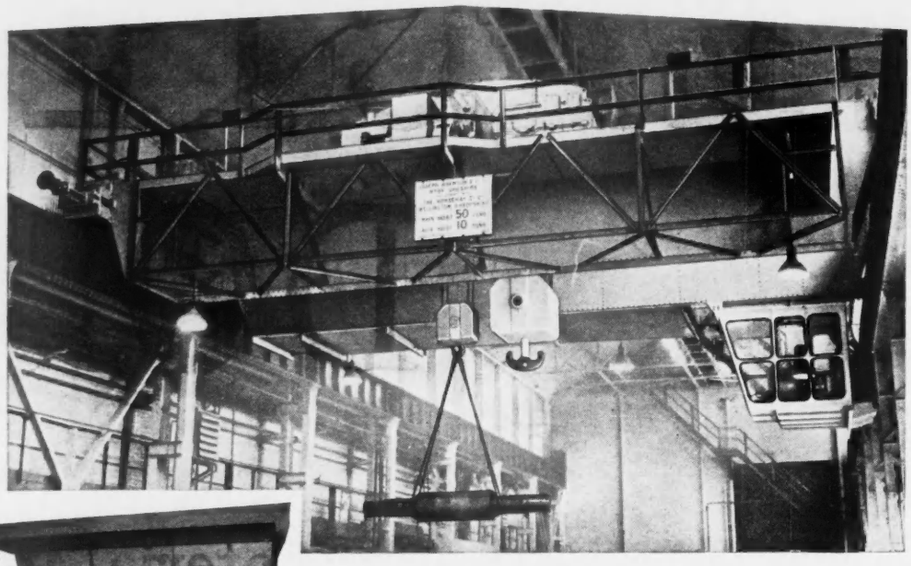

★ a view of the cab showing the seat control unit.

The Adamson 50/10 ton crane is the third of a series of new design supplied to Richard Thomas & Baldwins Limited, Ebbw Vale Section. Features of the crane include monolithic construction of the crab and the elimination of castings by mild steel fabrication of the hoist barrel and bottom block. The cab is of particular interest as it incorporates the most modern type of seat unit ensuring maximum vision and ease of control. Joseph Adamson electric overhead travelling cranes can be supplied to all specifications including cranes suited to the most exacting 24 hours-a-day process work.

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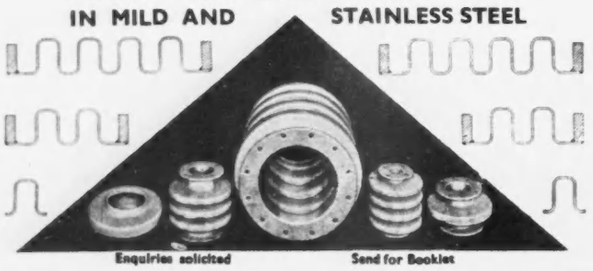

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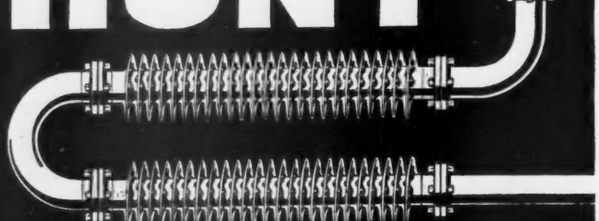

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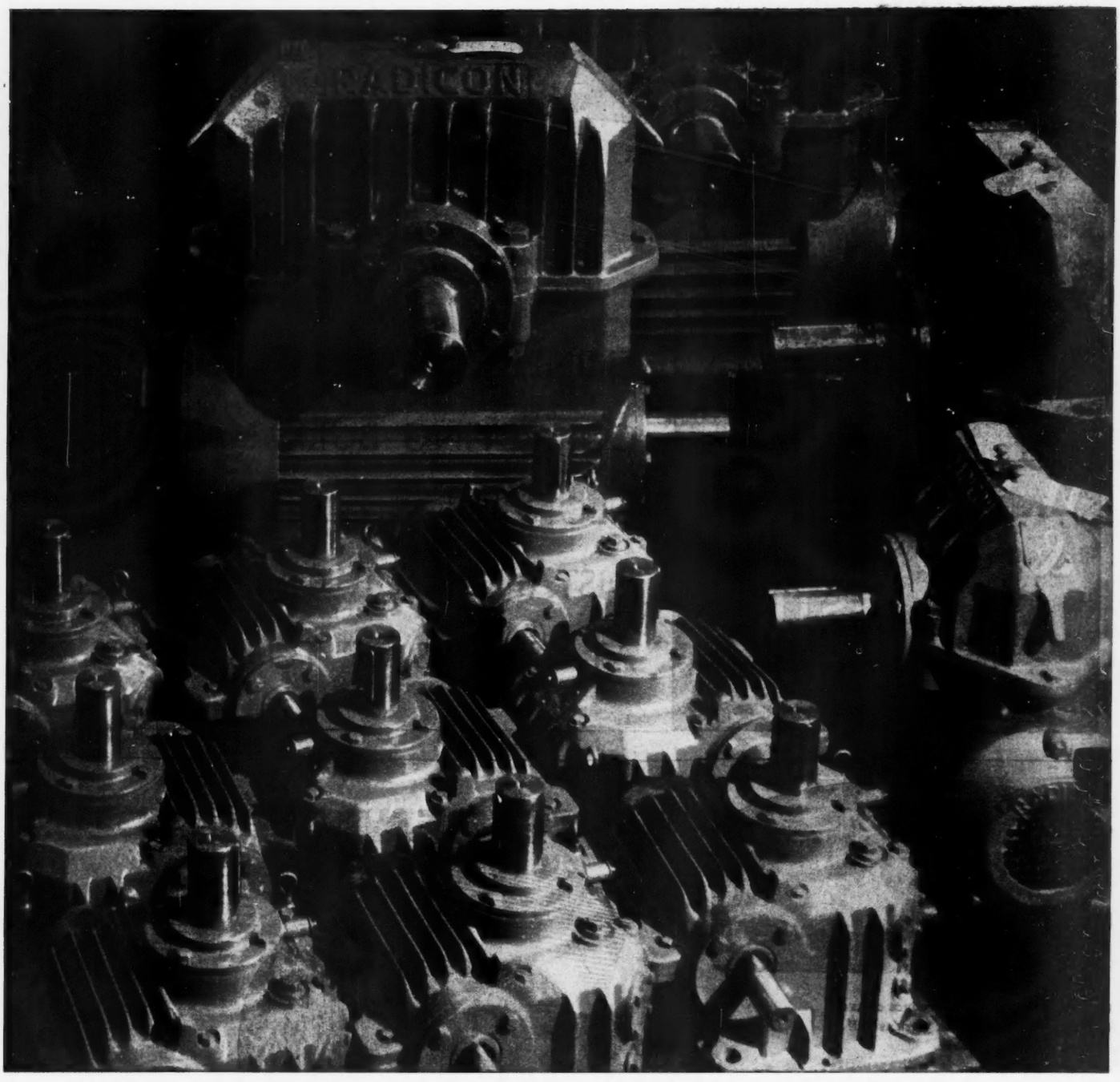

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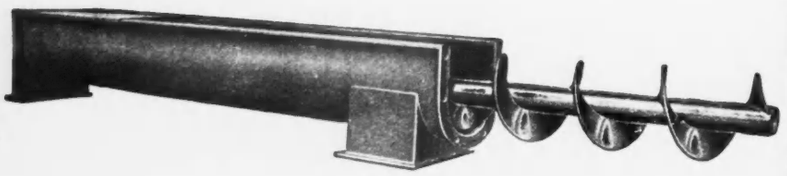

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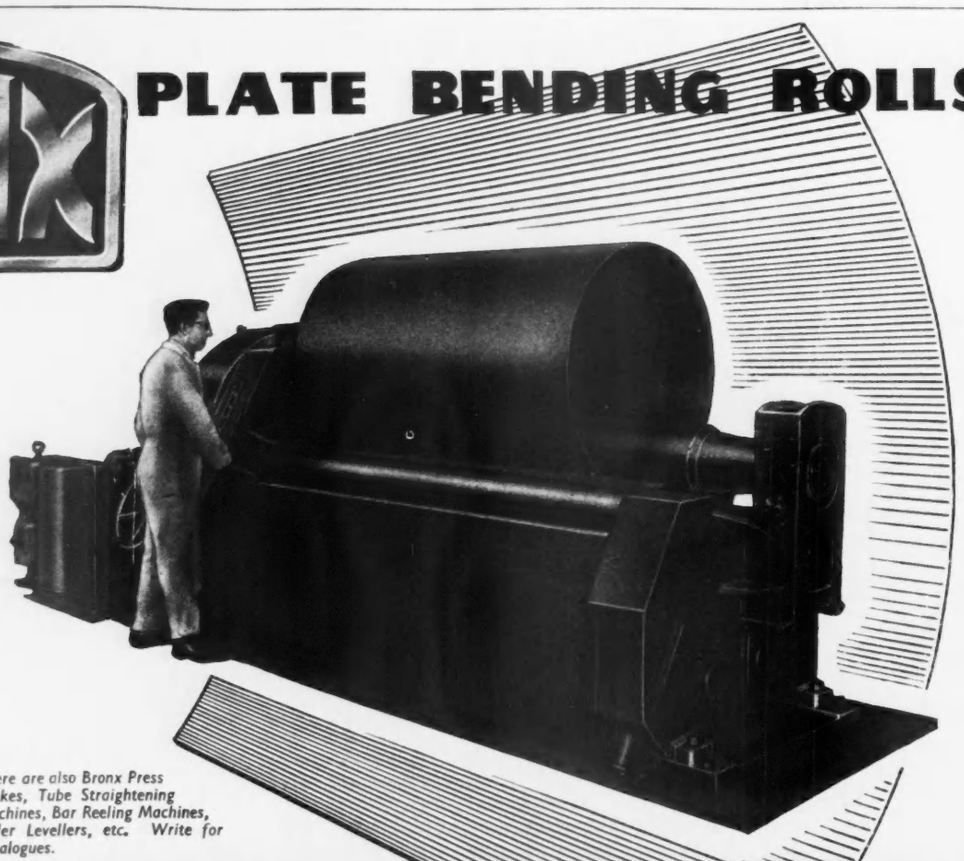
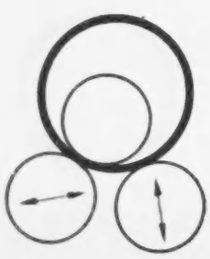
Illustrated is a Bronx 8′ x ¾″ capacity machine, installed at Messrs. Carrier Engineering Co.





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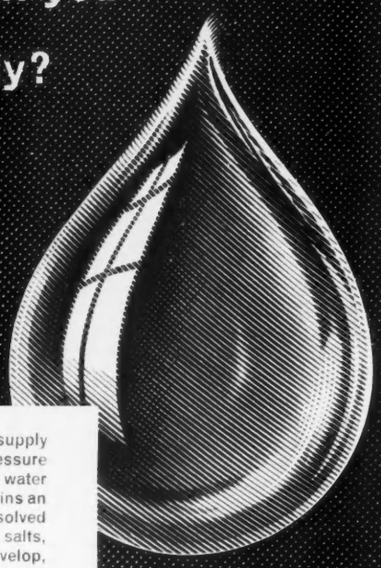
drop of water

could sink you financially?



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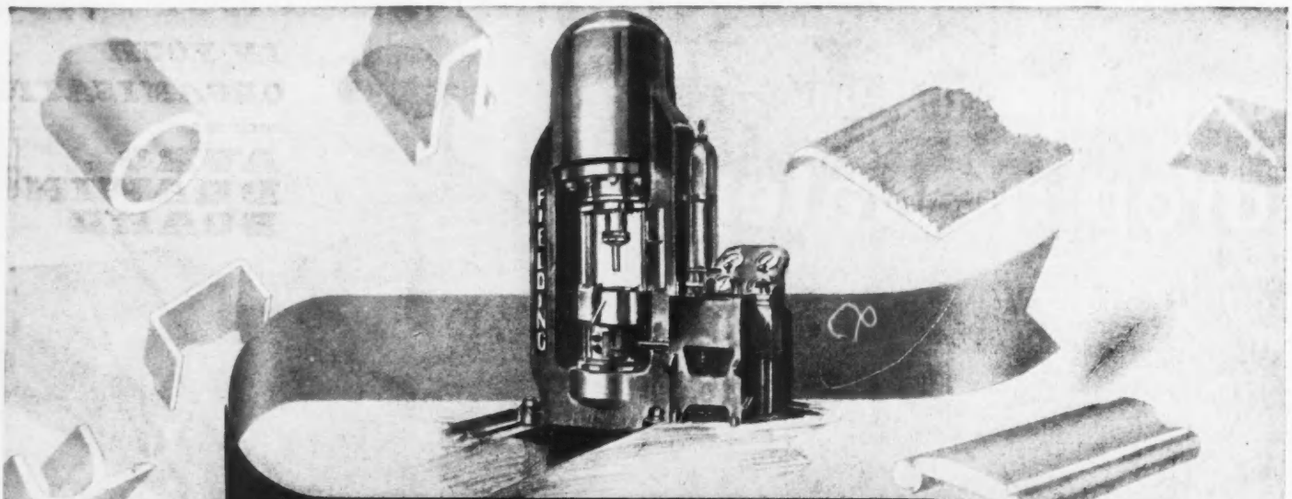

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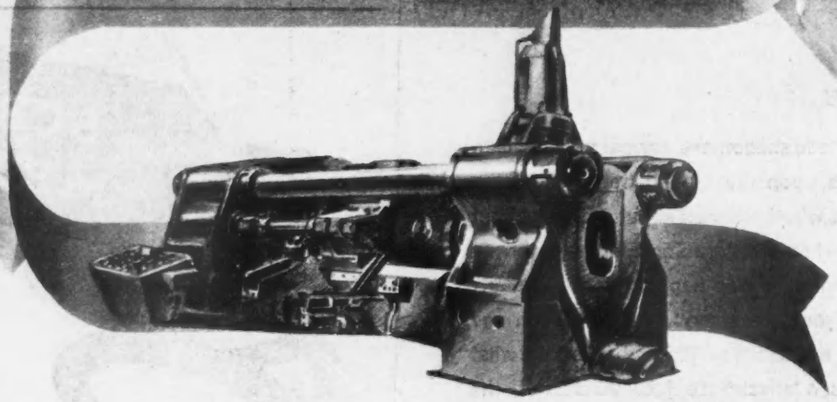

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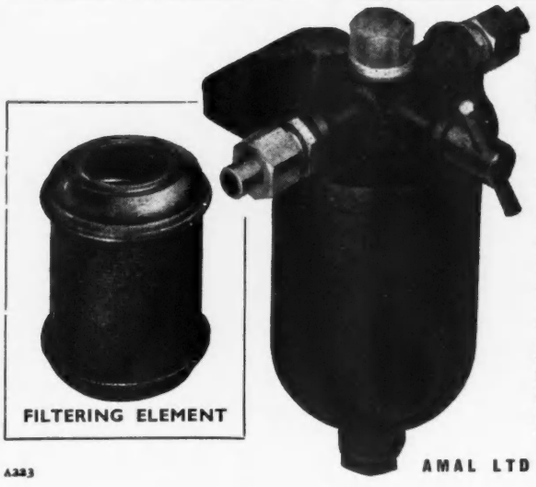

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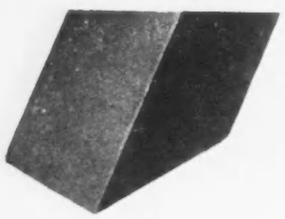

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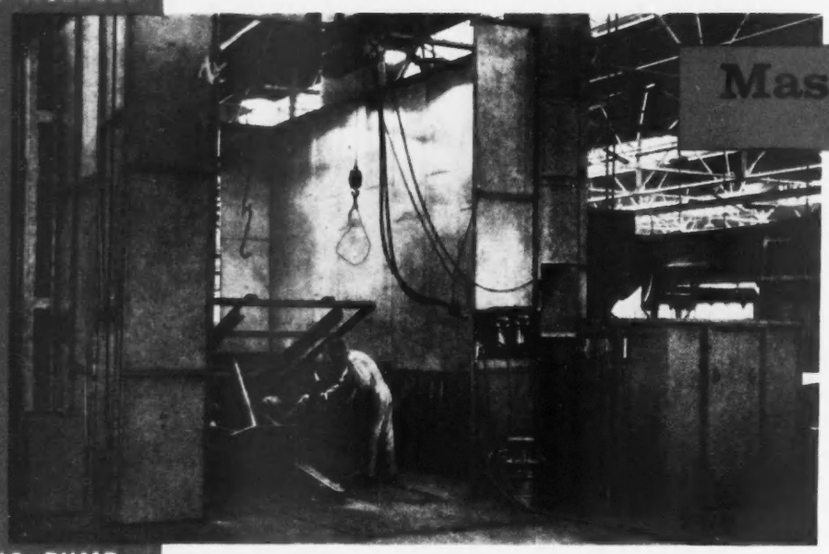

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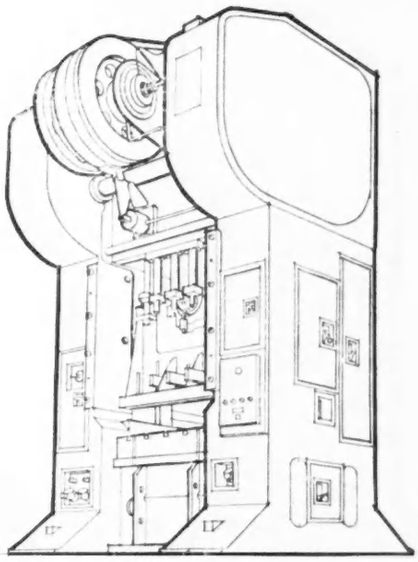

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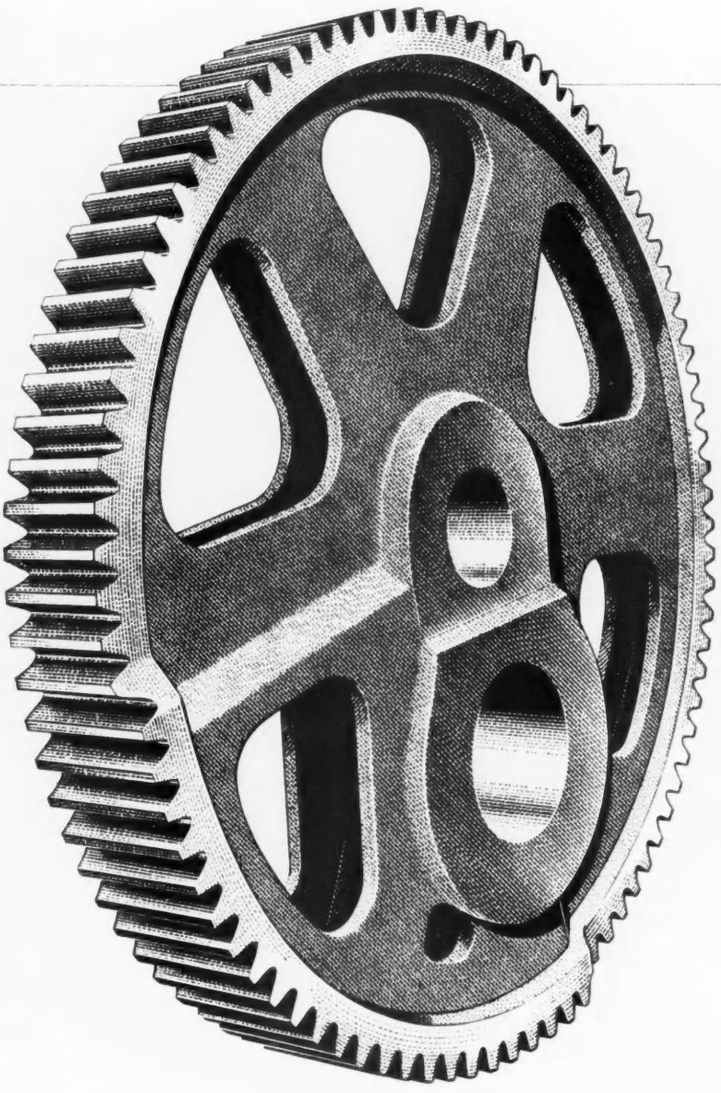

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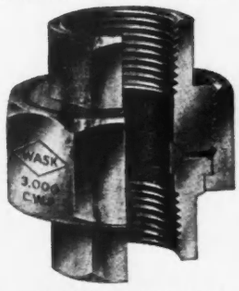

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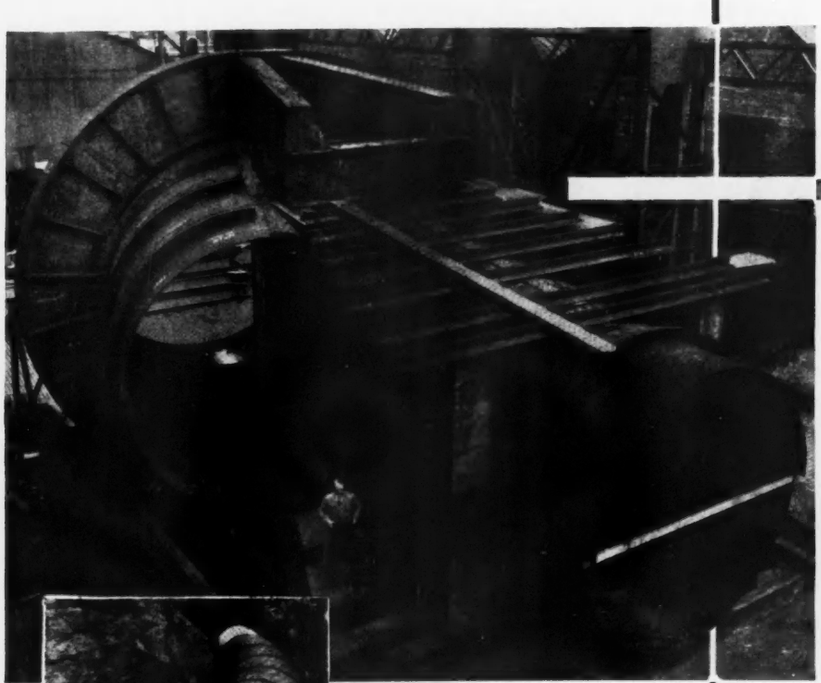

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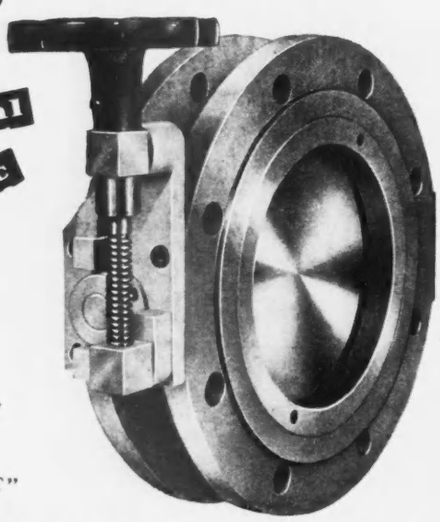
PAT. NO 753860



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Suitable for Water, Oil, Paraffin, Air, etc., up to 150 P.S.I. Weight approx. ⅓ that of usual type of valve.

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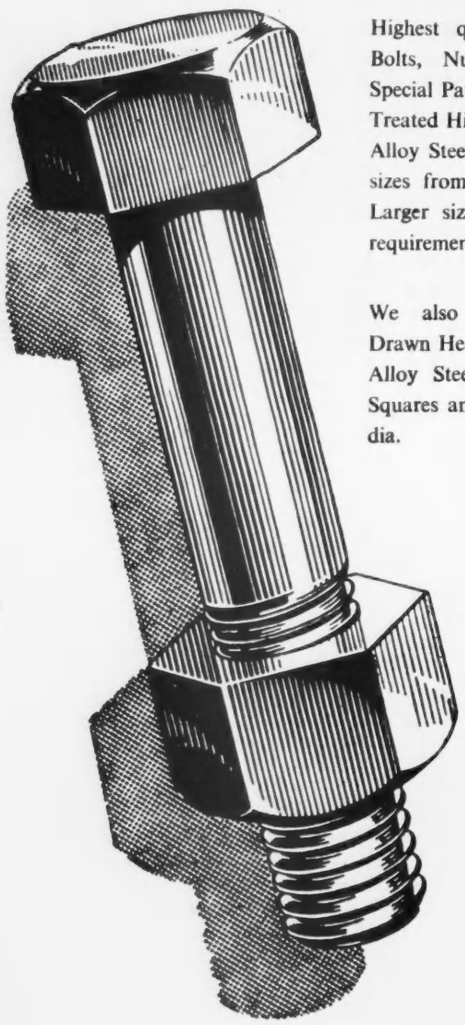

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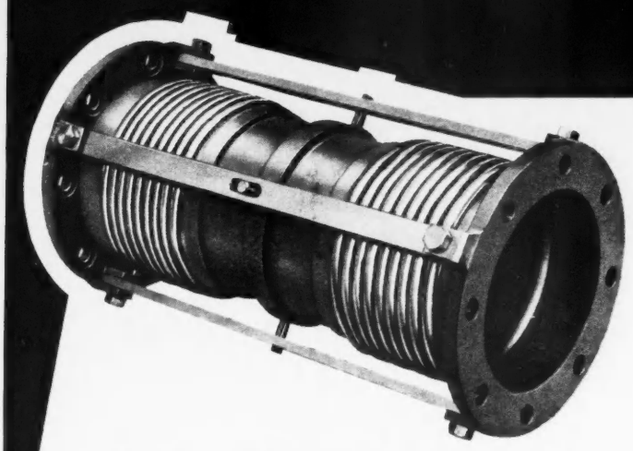

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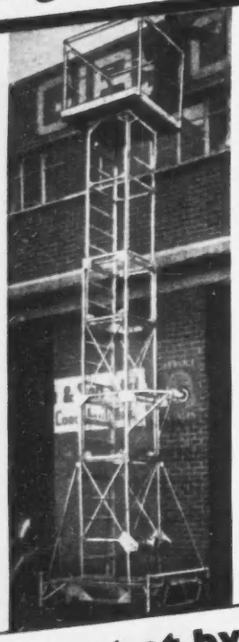

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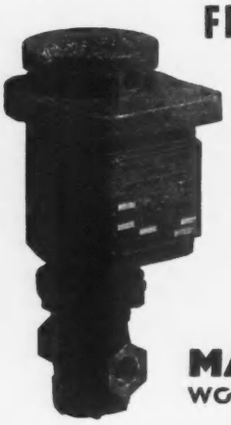

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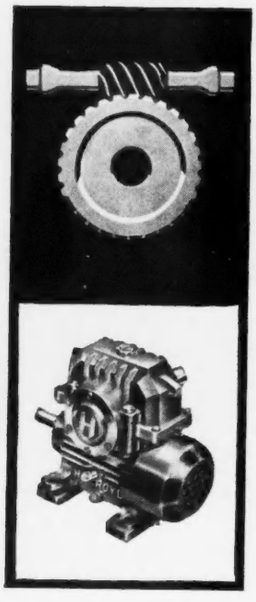

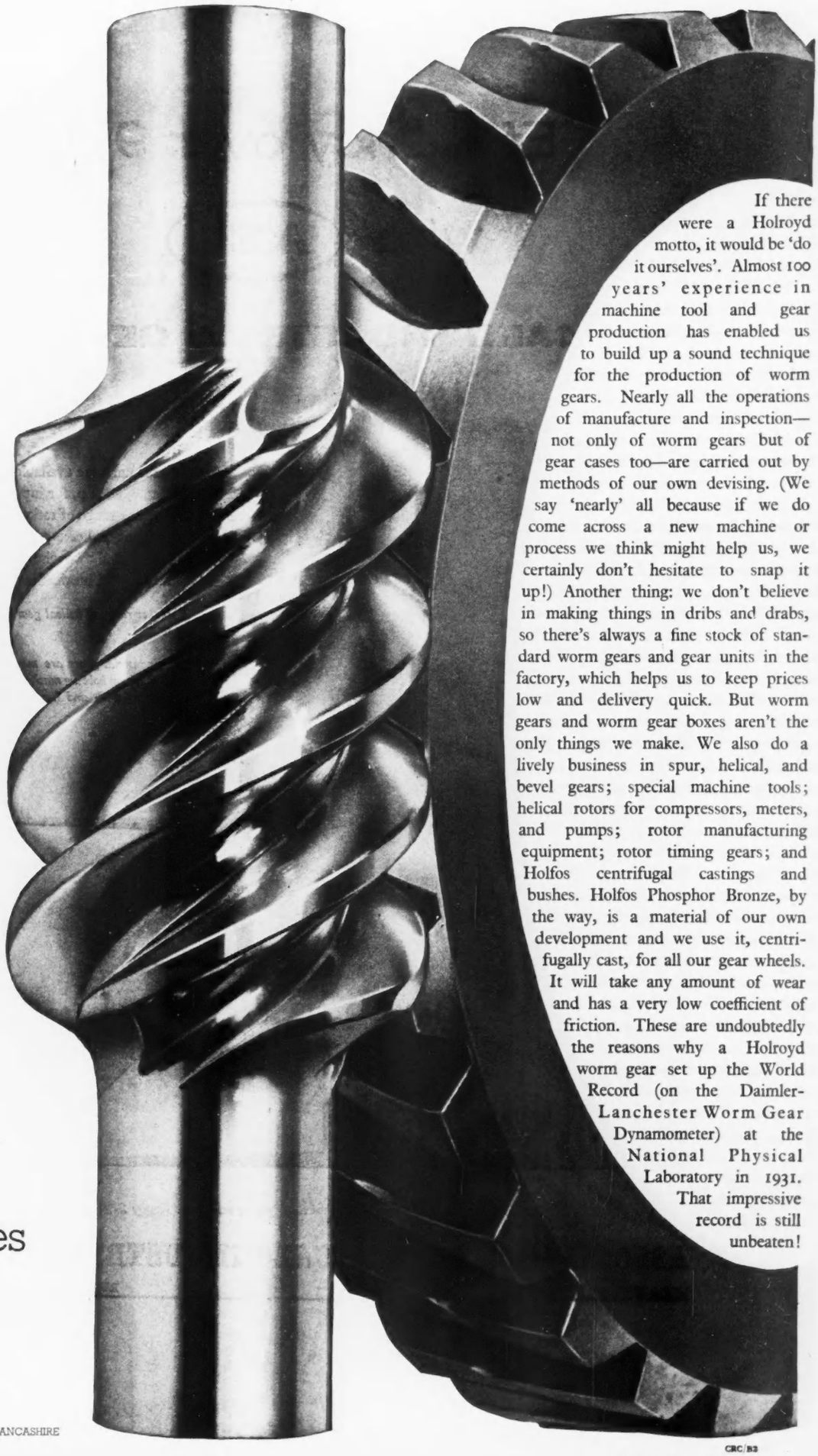

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first for
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and gearboxes

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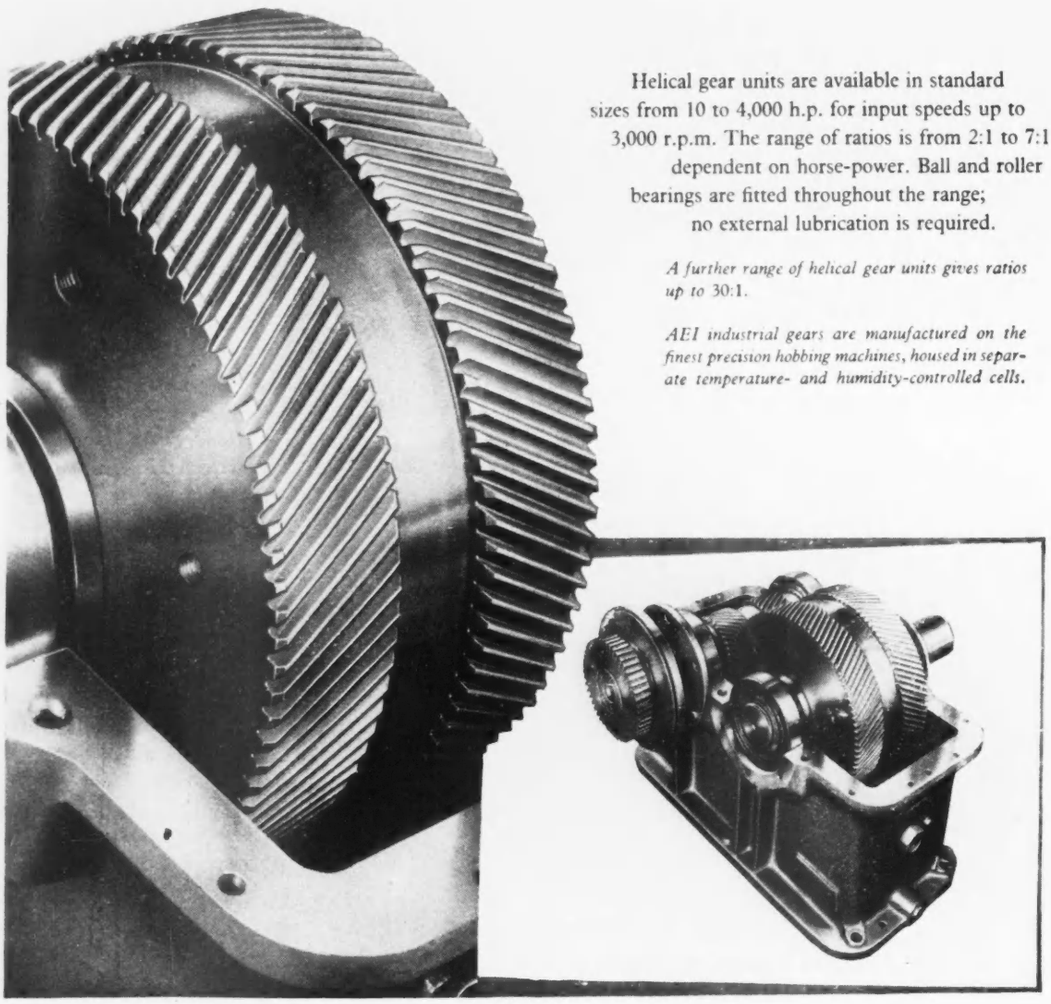

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SPEED REDUCTION DRIVES

"SHAFT-KING" is a most compact reduction gear unit "ready-made" to fit directly on to the shafts of your machines. Quick and easy to instal because it is fitted with an *exclusive* keyed tapered bushing, adaptable for various sizes of shafts. It can be connected by a short centre V-Belt drive from the input shaft to any make or type of motor and because of its smooth round compact design "SHAFT-KING" takes up little space and is easy to clean.

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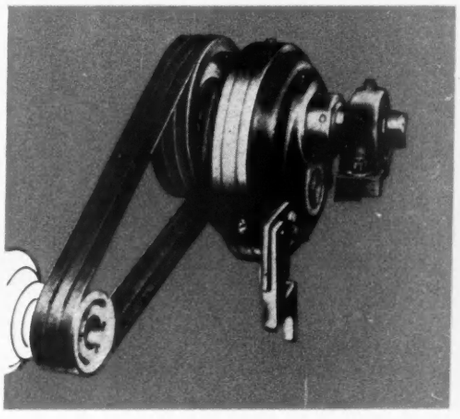
"SHAFT-KING" is available in three sizes for $\frac{1}{4}$ to 12 H.P. in two ratios 13 : 1 and 20 : 1. Other sizes will shortly be announced.

For economy, space saving, ease of selection and installation — there's nothing to beat the "SHAFT-KING".

We'd like to tell you and the guv'nor more about "SHAFT-KING", so please ask for our booklets.



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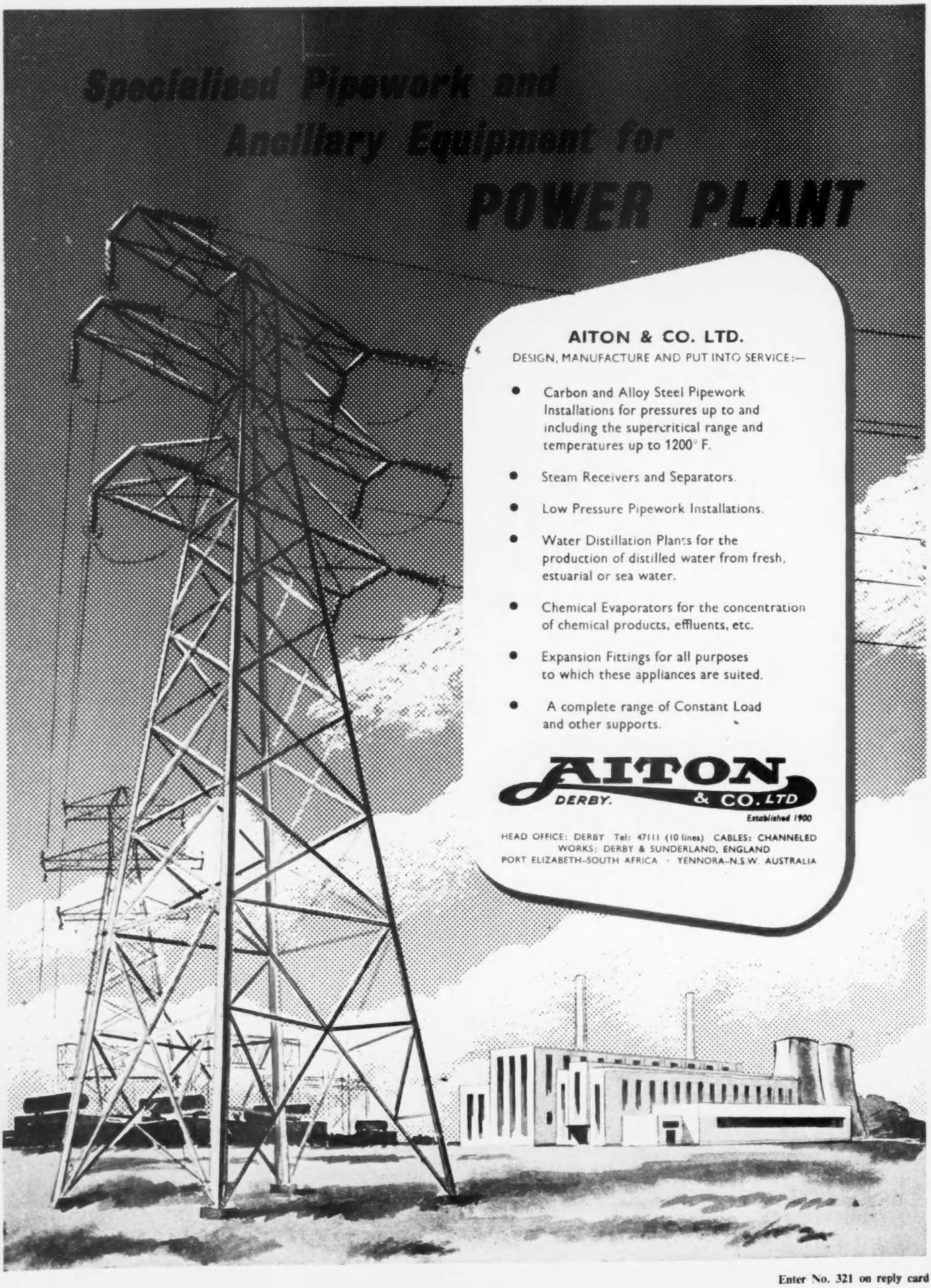
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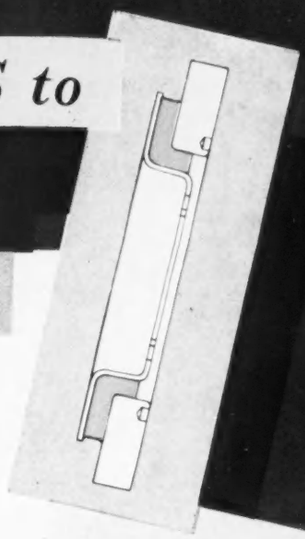
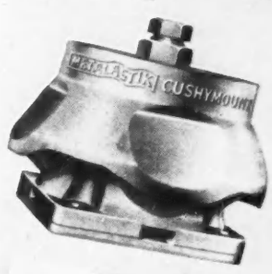


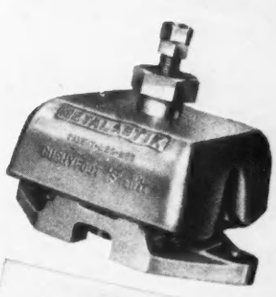
Prime movers are apt to transmit vibrations of one or more kind to their surroundings.

Torsional vibration can be reduced to a negligible quantity with the extremely simple Metalastik T.V. damper. Tailored to suit individual engines and sensitive to vibrations of the smallest amplitude, it permits a higher range of r.p.m. without detriment. Metalastik's unrivalled experience in analysing torsional vibration and designing dampers ensures success.

Out-of-balance forces, even with the best of engines, are often noticeable and here the patented Metalastik Cushymount and Cushyfoot 'S' mounting are of the greatest value. Cushymounts are ideal for the isolation of low-frequency vibration from diesel locomotive engines, large marine generators and other heavy machinery. Loads up to 5 tons per mounting are permissible and despite high deflections (up to $\frac{3}{4}$") no separate buffers or control links are needed. An adjustable buffer which limits excess movement is incorporated.



The Cushyfoot 'S' mounting is for the light-weight, four-cycle, high-speed diesel coming into general use on locomotives and is particularly suitable for the diesel-hydraulic. It provides a deflection of 0.25" under a load of 2,500 lb. and accommodates shunting shock loads up to 5 g. Adjustable buffer is incorporated.



For resonant torsional vibration in the marine engine/propeller-shaft system, the patented Torque Transfer coupling is an effective and economical solution providing, initially, a very low stiffness with a much higher value for a pre-determined torque.

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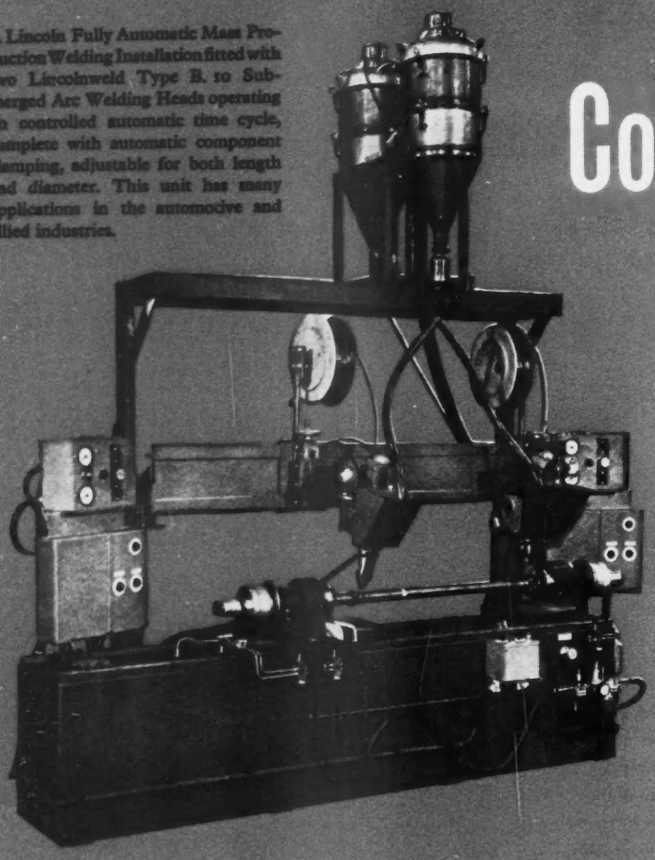

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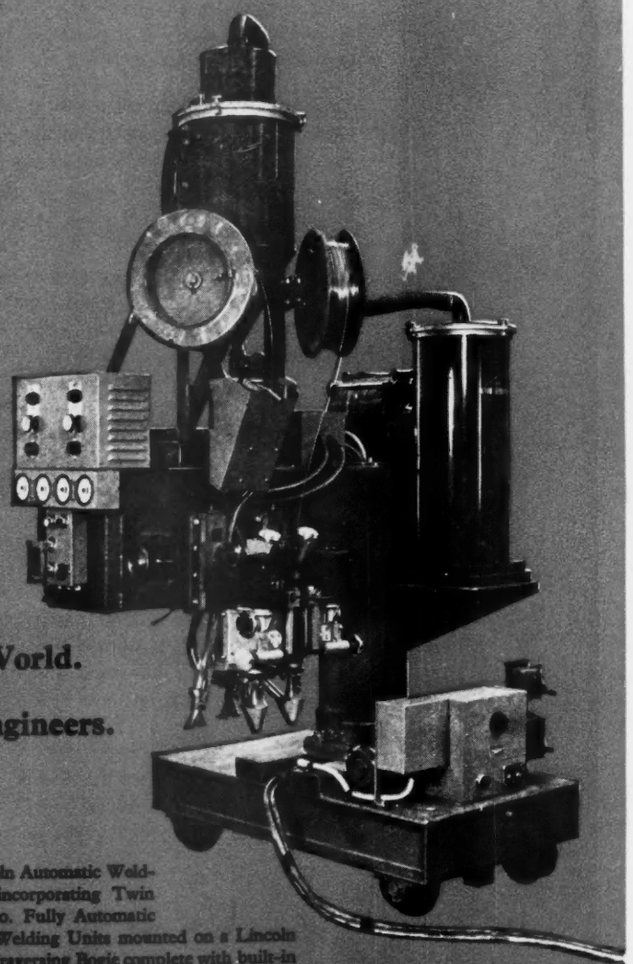

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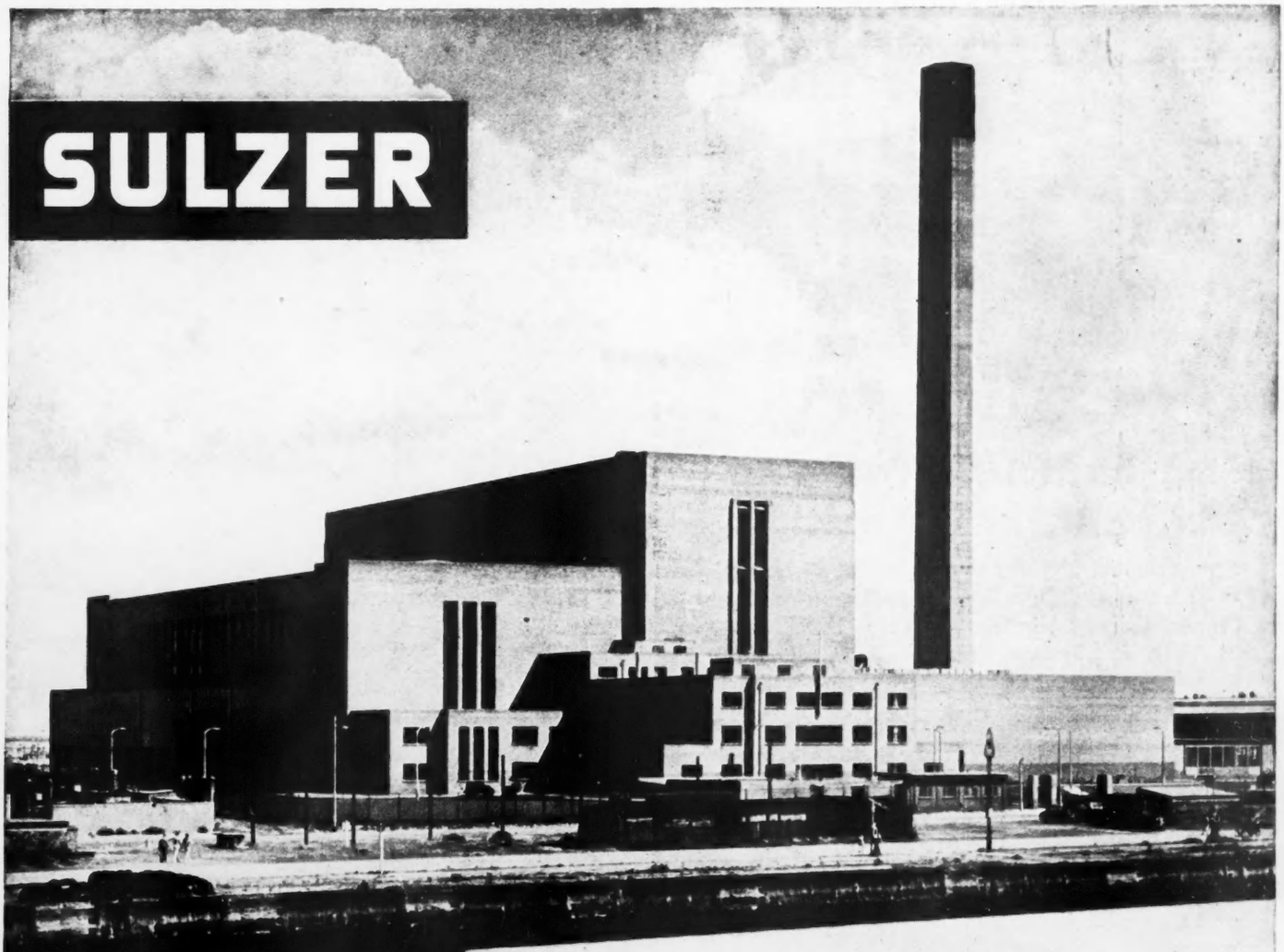

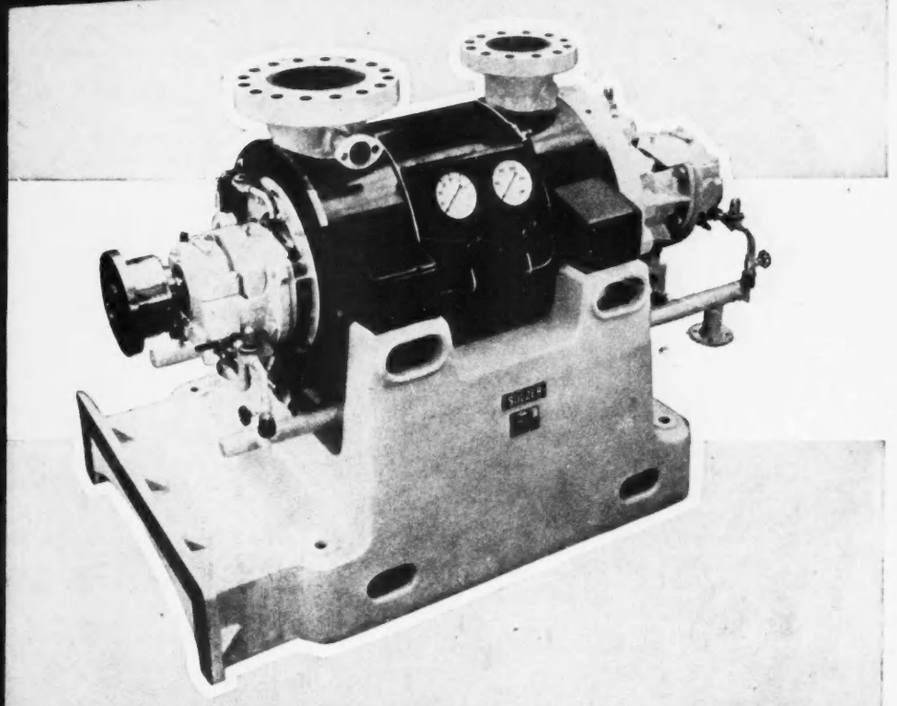

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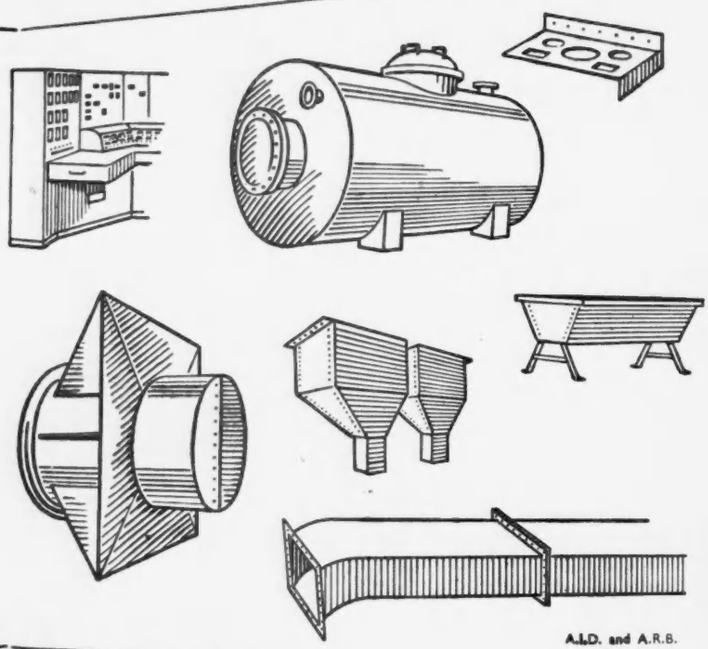

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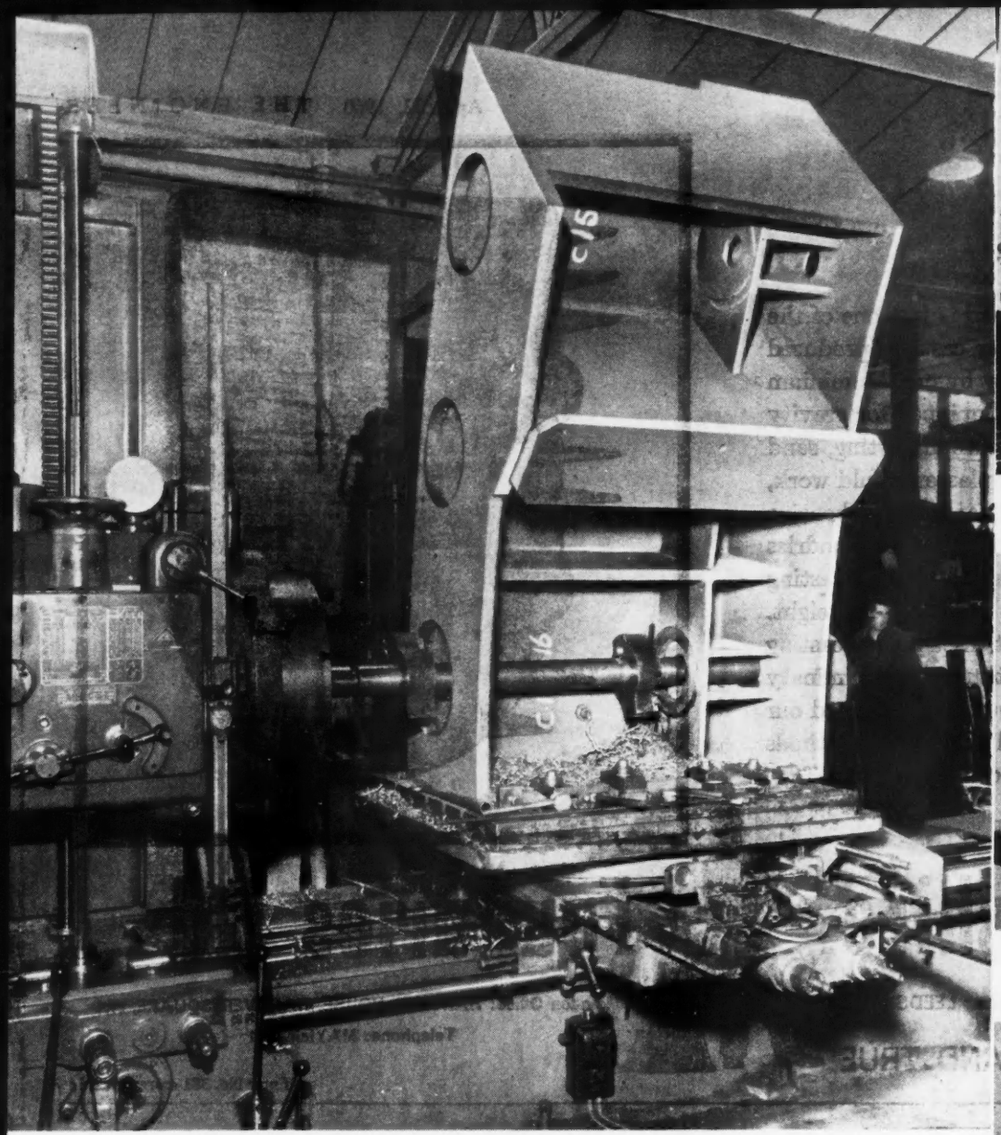
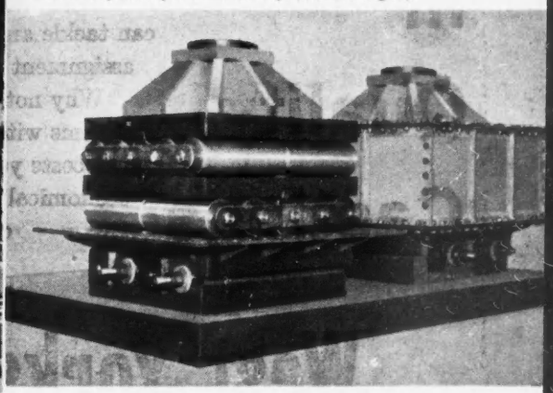
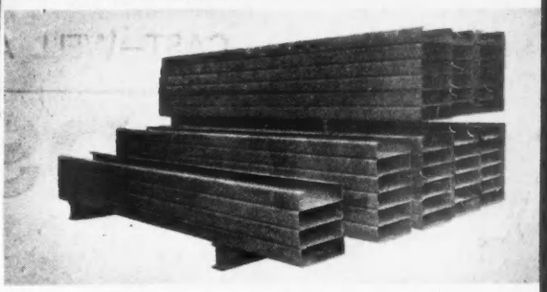


A large component in the course of manufacture in our machine shop

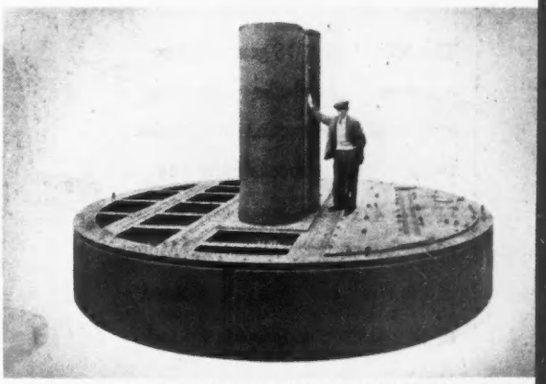
Twickenham Flyover. This bridge is curved in plan, and each of the three spans was completely welded at works and delivered by road and rail to the site. Max. length 75ft., width 15ft.
Illustrated by courtesy of British Railways (Southern Region).



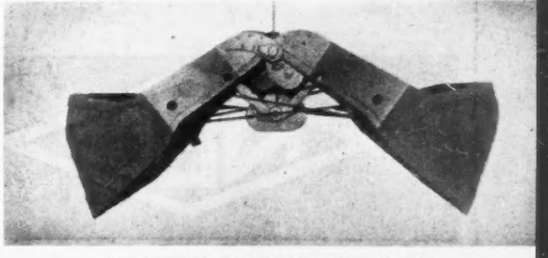
Bearings designed and constructed to suit all conditions including single, double and triple roller, expansion, hemispherical and fixed rocker bearings. Illustrated are two Universal Bearings to support 250 tons, allowing for horizontal movement in all directions and also vertical adjustment. One bearing with grease castings removed.



Part of a consignment of Pressed steel channels.



A composite riveted and welded air deck for a vertical shaft, with some of the plates removed to show the construction. One section of the "Figure of Eight" shaft is shown in position.
Illustration by courtesy of Shell Petroleum Co., Ltd.
Contractors: John Mowlem & Co., Ltd.



Four-Rope Grab of the Wide Span Type. Ref. 329.

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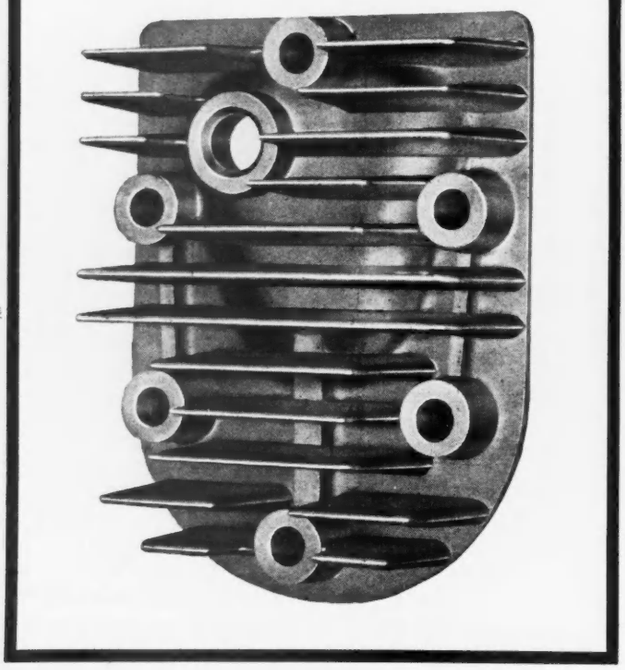

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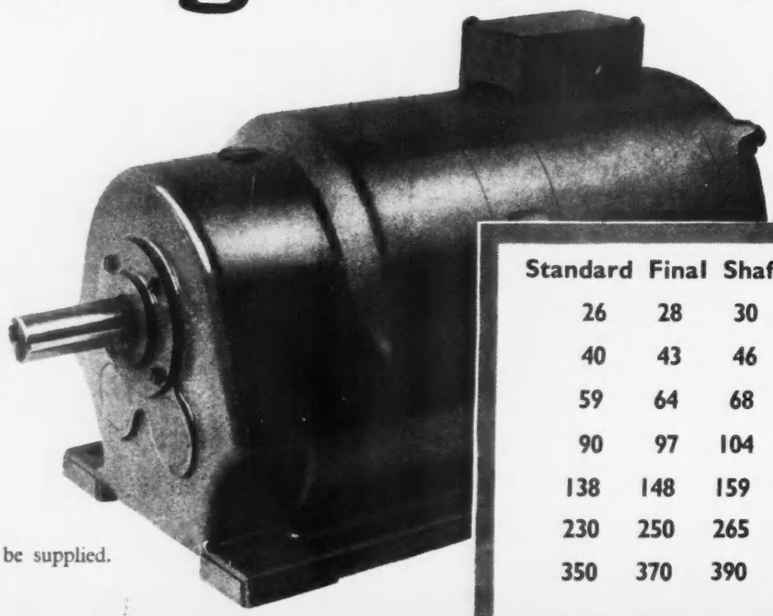
Type DS geared motors



The NECO type DS geared motor is a co-axial straight line drive unit of compact construction with a wide choice of output speeds from 0.25 r.p.m. - 475 r.p.m. and is available for either foot or flange mounting. Motors of 1/6, 1/4, 1/3, & 1/2 h.p. are fitted to the gearbox to provide up to 100 lb.ft output torque.
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40	43	46	50	53	57
59	64	68	73	78	83
90	97	104	112	120	128
138	148	159	170	200	215
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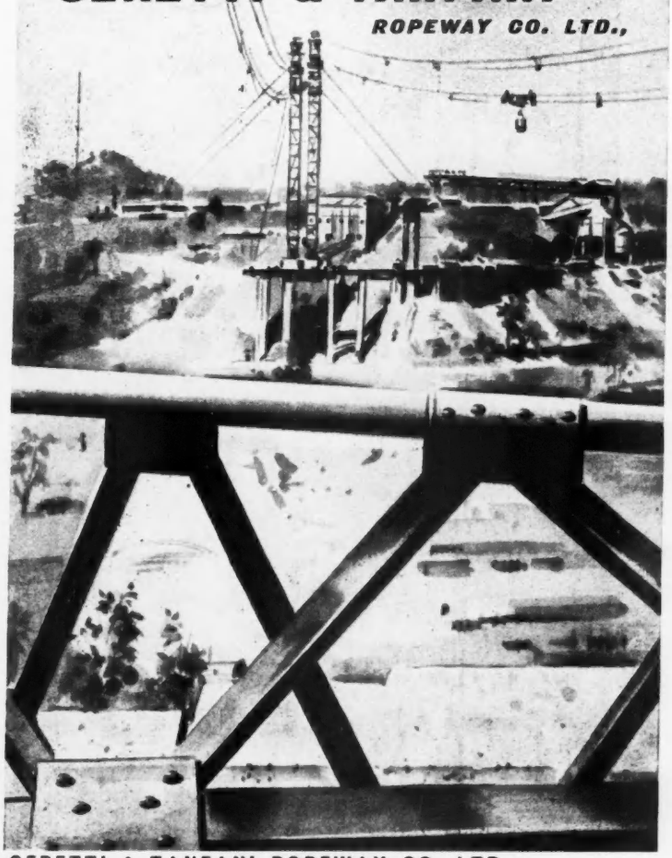

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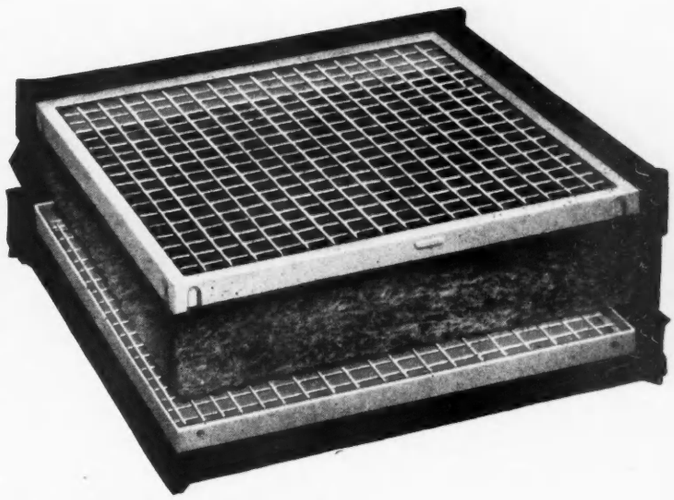

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3 **Wide applicability**
4 **Simple installation and care**
5 **Maximum effective face area**
6 **Dependable performance**
7 **Long life through sturdy construction**

Small filter banks can be constructed merely by bolting or riveting the outer frames of the filter cases together; and these filters are also interchangeable for size with most standard panel-type filters for which frames may exist.
Write for leaflet describing the simple design for low cost maintenance with high filtering efficiency.

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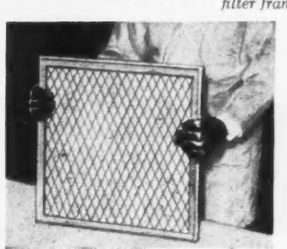
The D/C Filter is unusually easy to service, requiring only periodic media pad replacement. Media changes can be made by unskilled personnel.

Remove filter case from bank. Snap out inner filter frame and remove used media pad.

Insert new media pad into outer frame, line up media edges, and snap filter frames together



Replace filter case in the filter bank. When filter cases are bolted or riveted together insert new media at the filter bank by just snapping out the inner filter frame.

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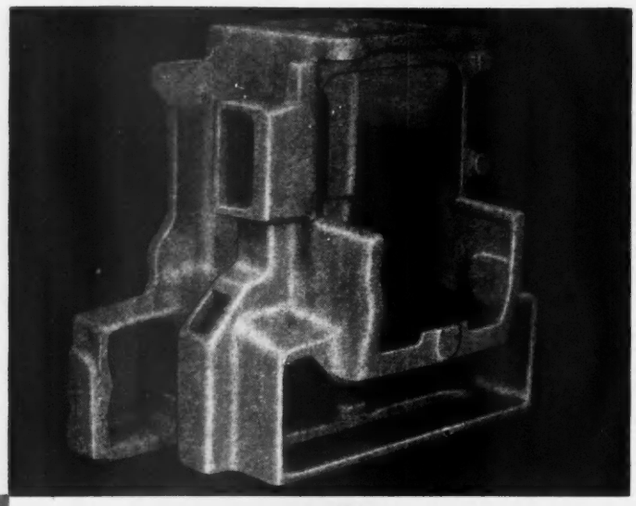

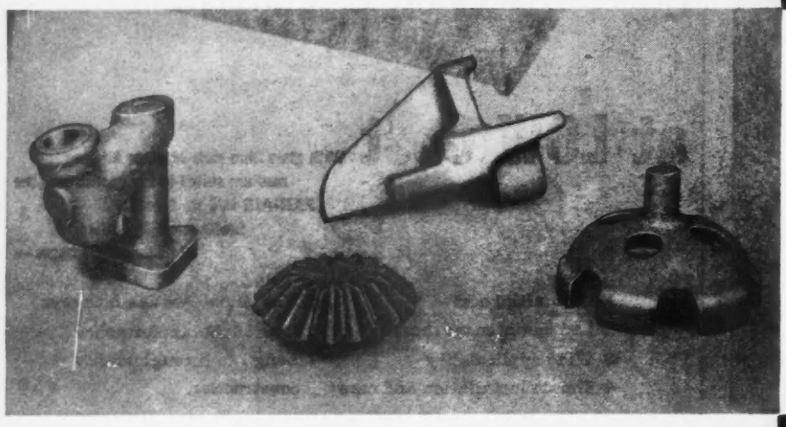

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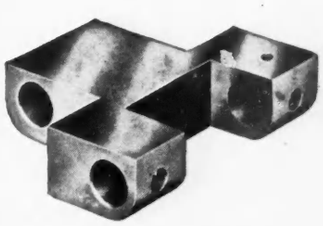

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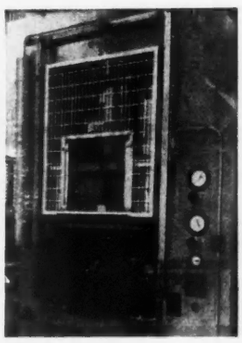

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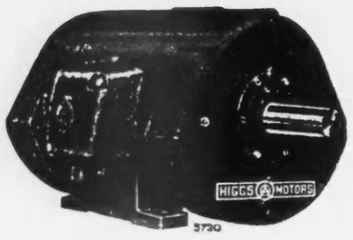

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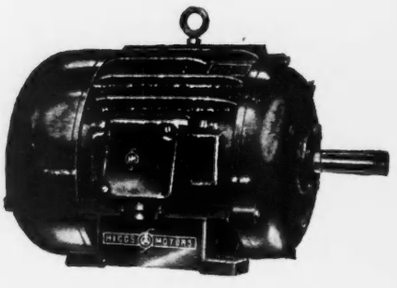

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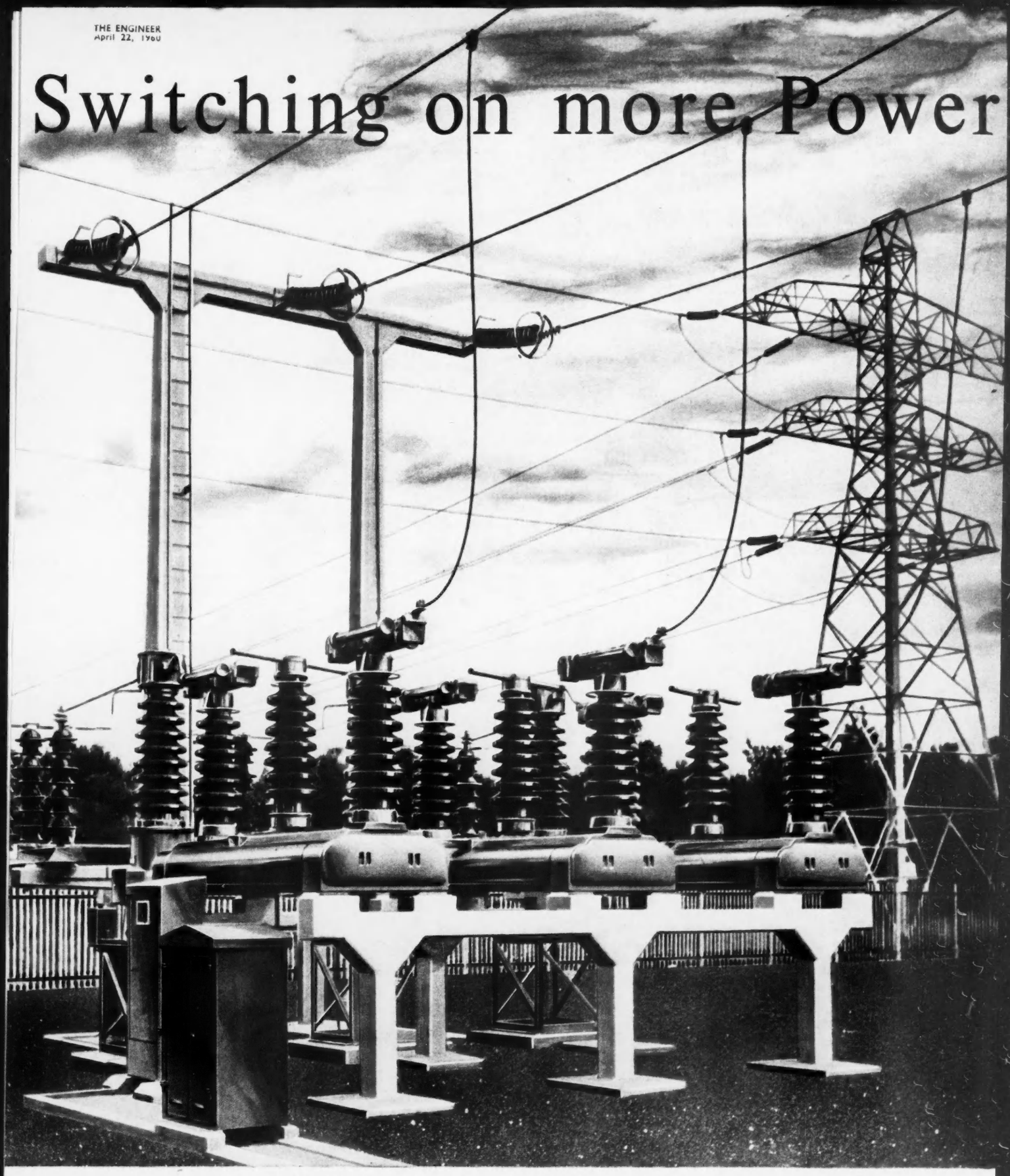

The photograph shows a 132 kV., 3,500 MVA., Type GA6W4 Air-Blast Circuit Breaker installed in a British substation

This type of breaker is in extensive use on the British grid system, and has been selected to control the output of Scotland's first Nuclear Power Station at Hunterston. Overseas, 132kV., 5000-MVA., Type GA6W4 breakers will be installed in seven new sub-stations in the Greater Buenos Aires area of Argentina.

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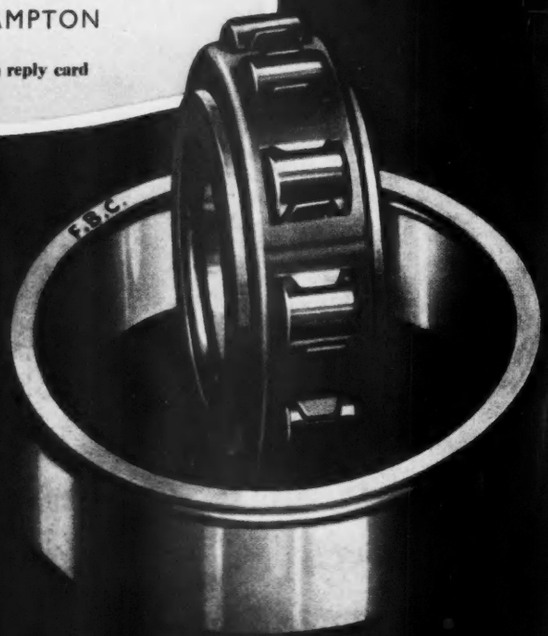

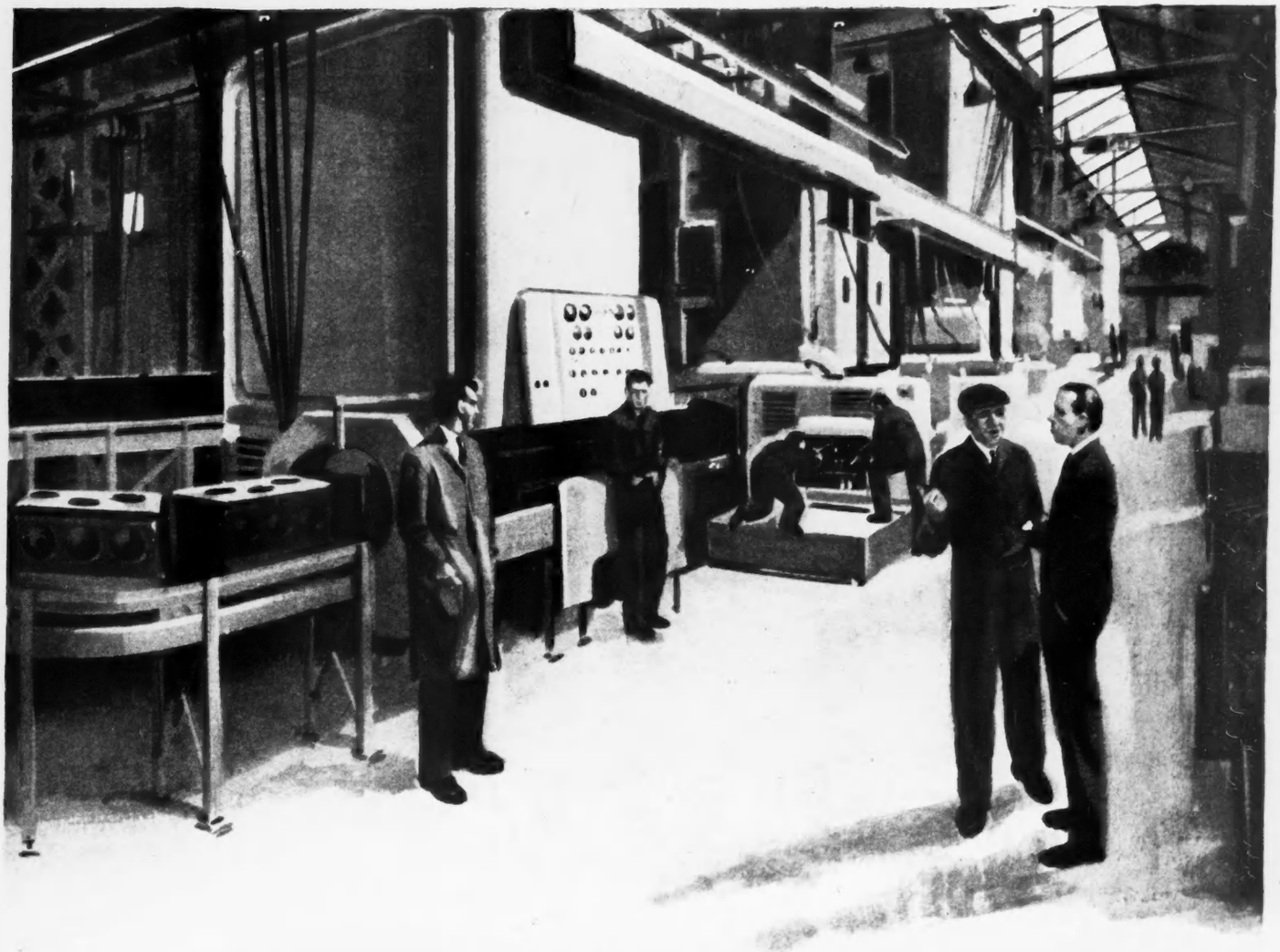

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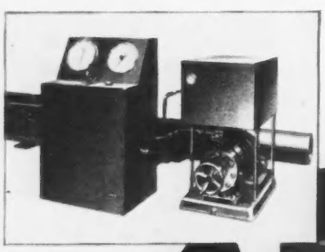
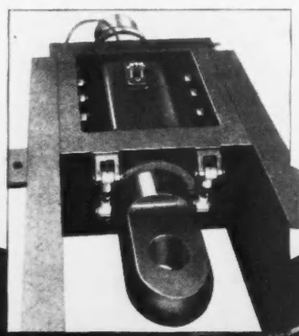
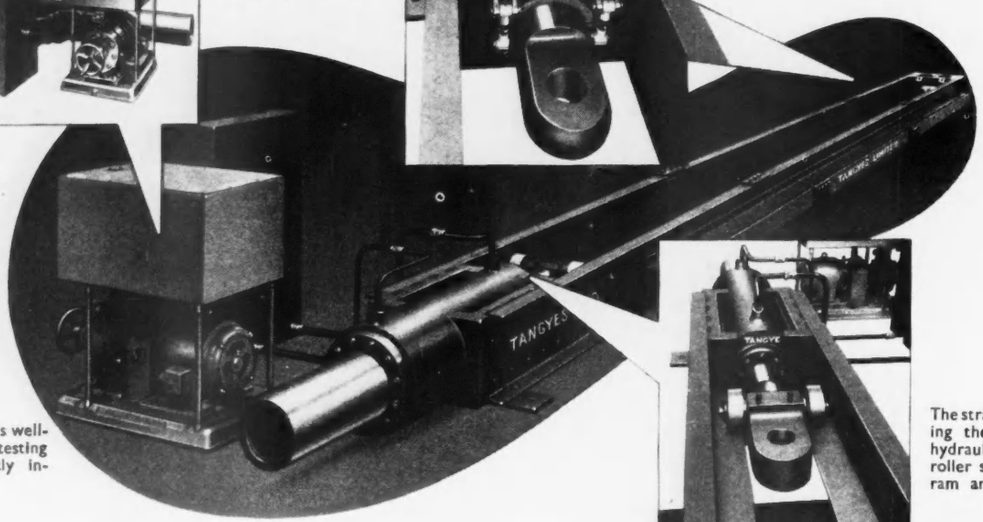
TANGYE CHAIN TESTING MACHINES



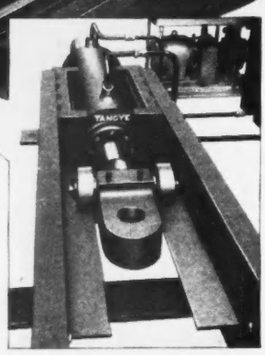
View from operating position showing control Cabinet and pump with oil reservoir.



The resistance head showing linkage support to eliminate friction. Hydraulic capsule and capillary tube also shown.



A Tangye 100 tons well-type chain testing machine recently installed.



The straining end showing the double acting hydraulic cylinder and roller supports for the ram and tension rod.

This range of machines is for testing chains, shackles, complete lifting blocks, large rings and similar gear. One of the many features of these machines is the use of a tension rod which is suspended on links to take its weight and the weight of the specimen, thus preventing the rod contacting the bore and constituting a resistance. The pull being applied during a test is registered by a sensitive load capsule located on the tension rod, the capsule in turn being connected via capillary tubing to a dial-type load indicator.

Two types of machine are supplied, "Platform" or "Well" types, and these can be arranged for almost any working load, stroke or length. Examples of dimensions and capacities of machines now in use are shown in the table.

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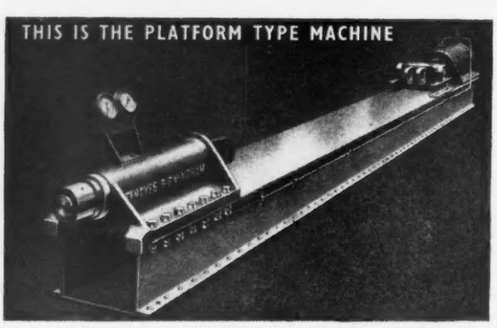
THIS IS THE PLATFORM TYPE MACHINE



EXAMPLES OF CAPACITIES OF MACHINES NOW IN USE SHOWN BELOW

	Platform Type				*Well Type*			
Working Load. *In Tons* ...	50	75	75		15	30	50	100
Stroke of Straining End Piston. *In Inches*	36	36	36		30	30	30	36
Centres of Eye Ends on Tension Rods	30′	34′	16′		20′ 6″	30′ 6″	25′ 9″	51′

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- ✳ Precision-machined internal gearing for smooth running and self-starting
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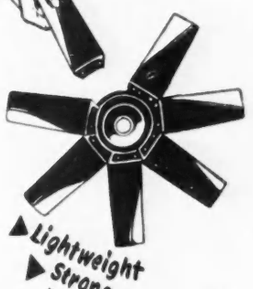

- Lightweight
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- Spark-proof
- Acid-proof

Blades are strong but can be replaced quickly and cheaply in the event of accidental damage.

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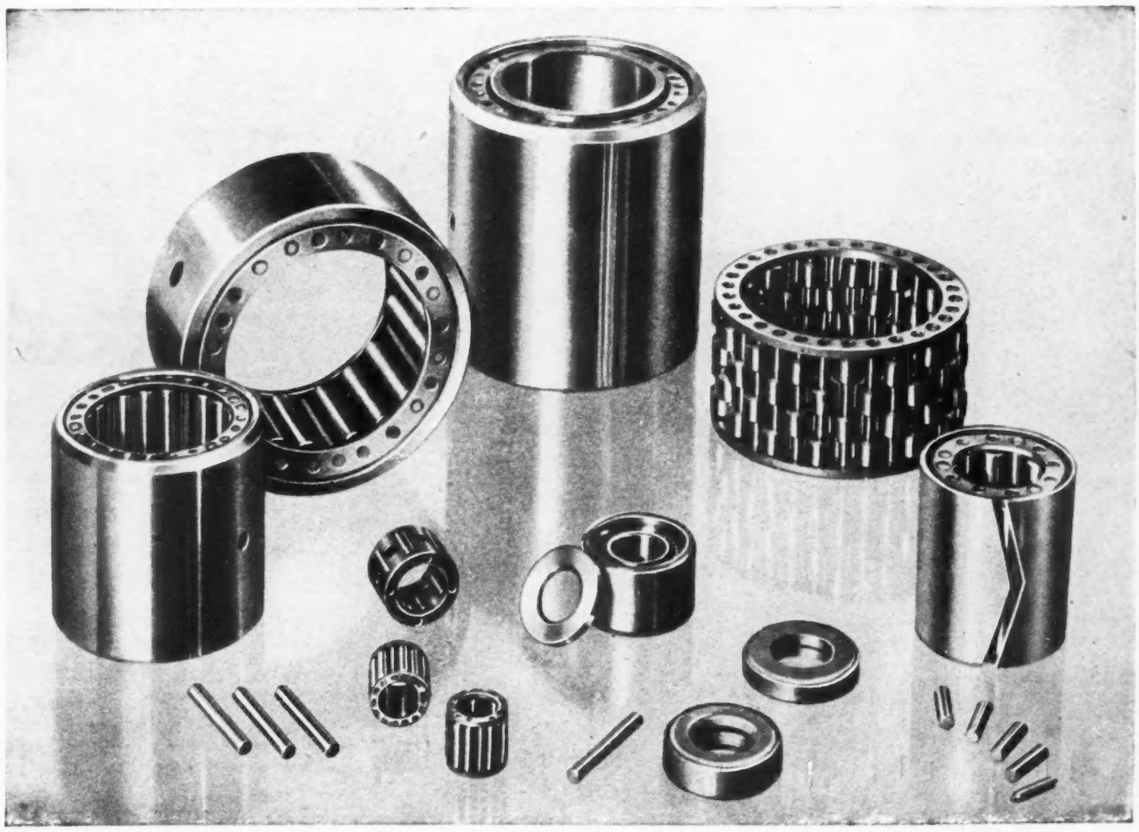

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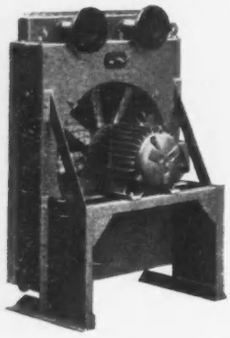

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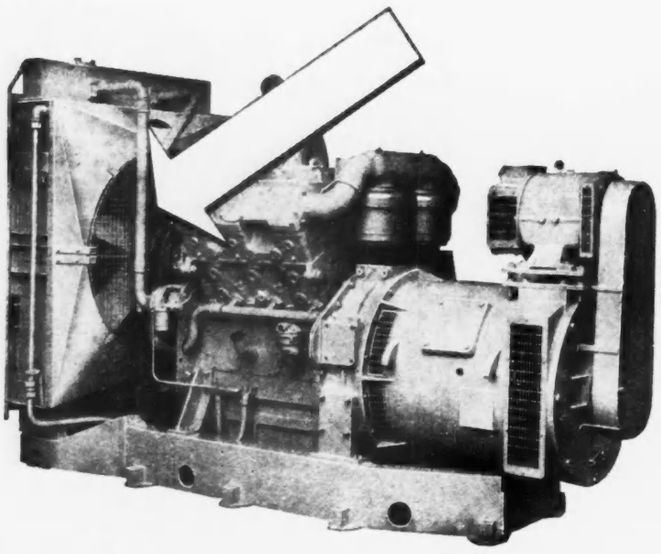

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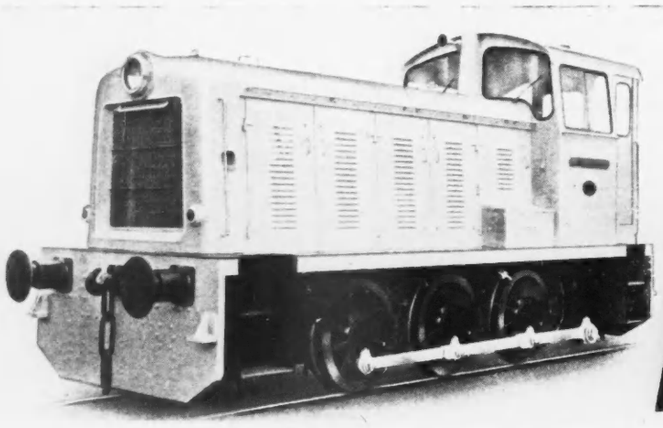

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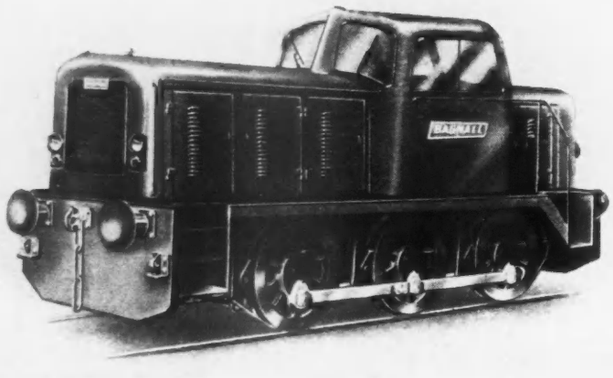

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Weight 48 tons
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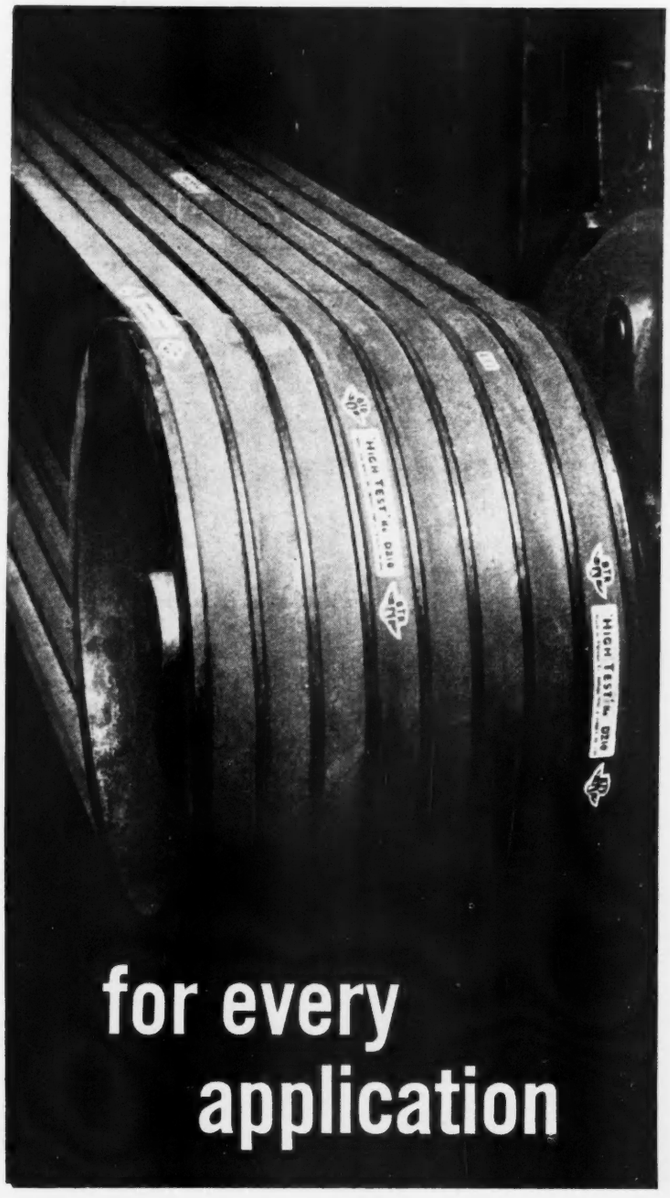
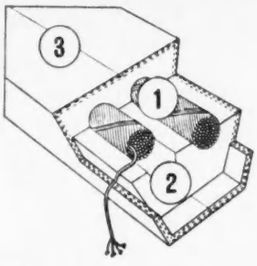


there's a **BTR** High Test V-Belt



This diagram shows (1) the load-carrying members (2), the rubber cushion and (3) the 2 ply cover of specially woven wear resisting material of a BTR High Test V-Belt. This Grommet construction is available in Sections B, C, D and E.

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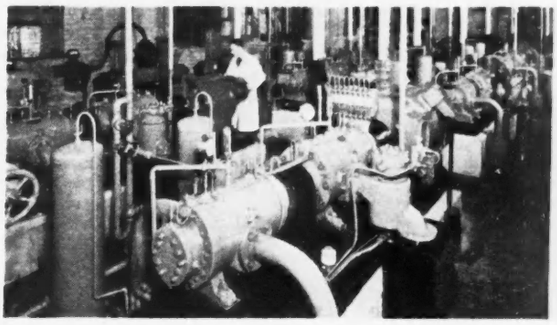

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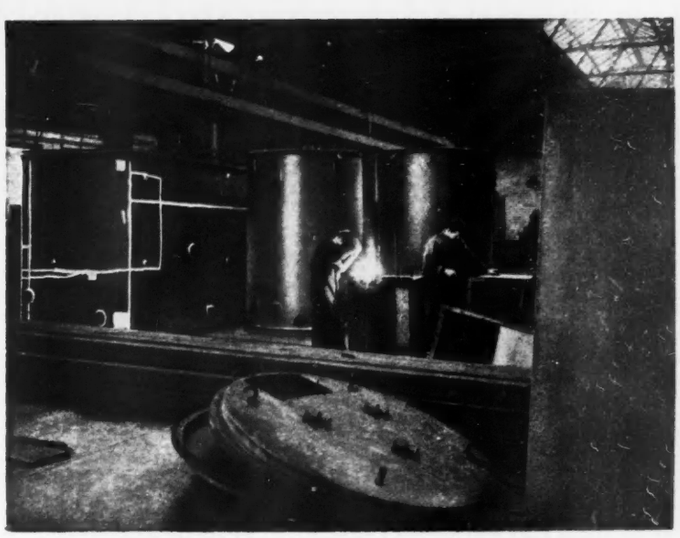

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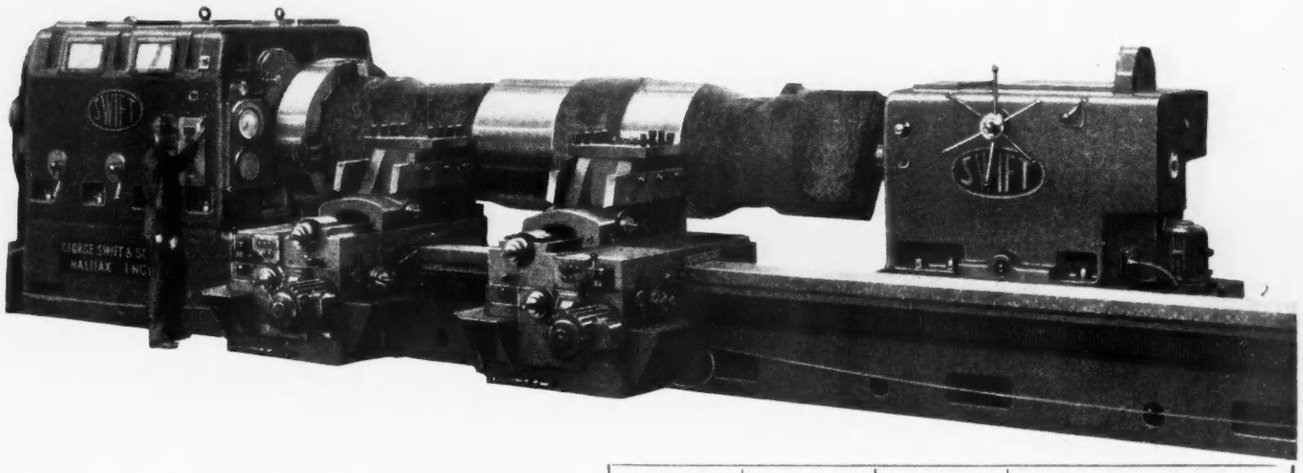

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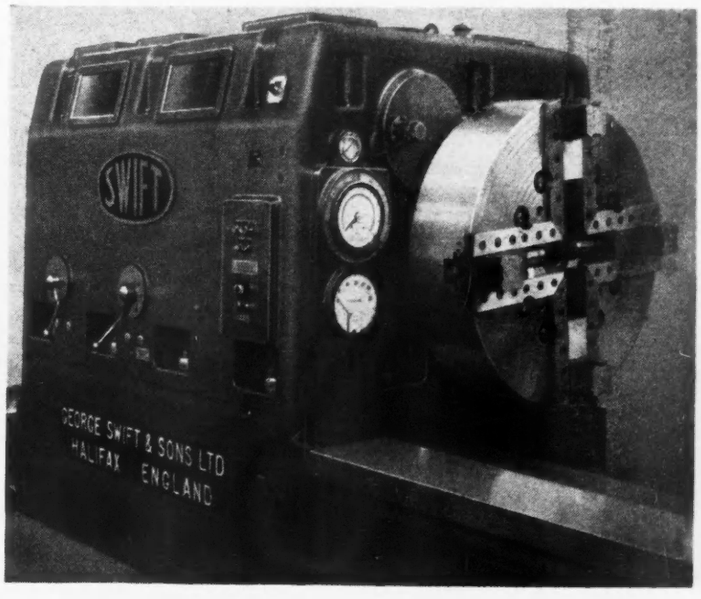

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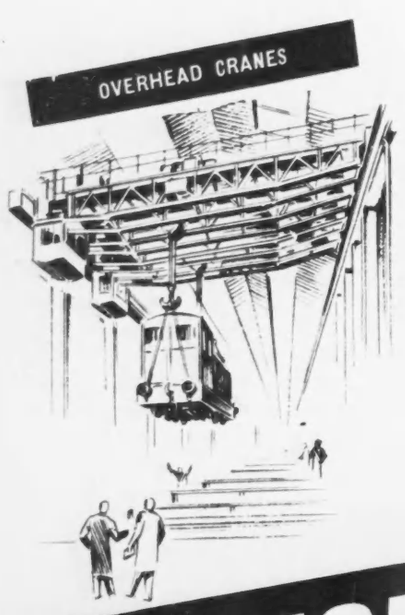

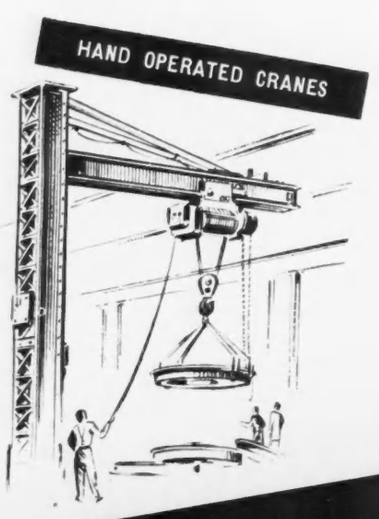

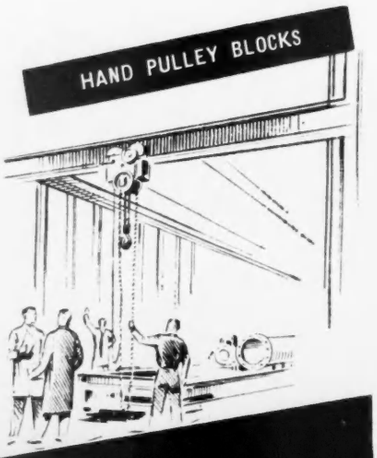

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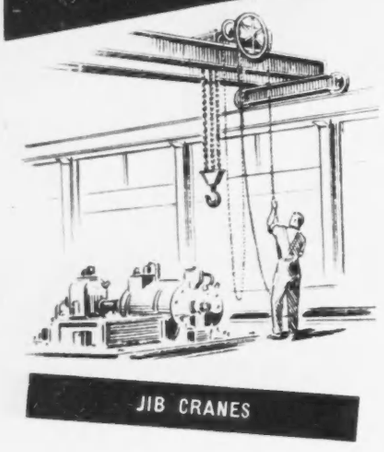

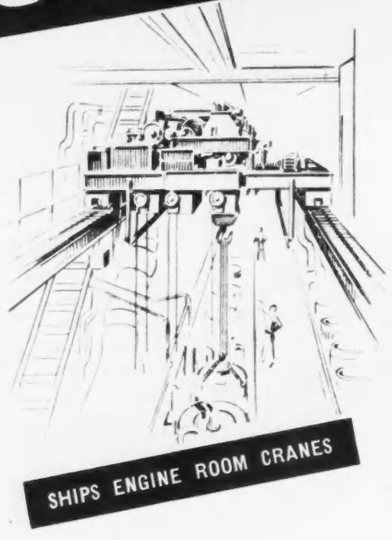

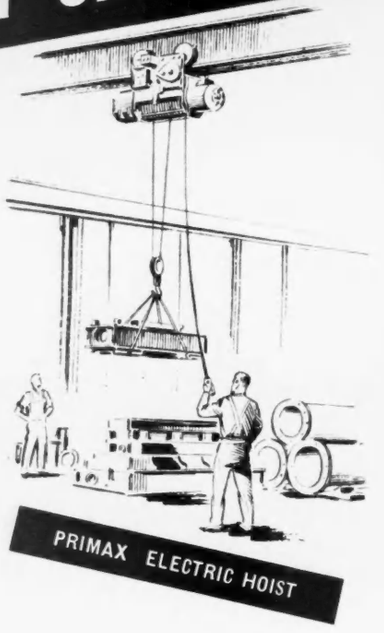

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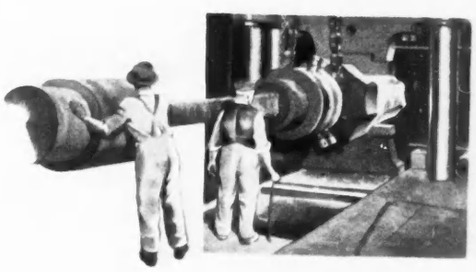

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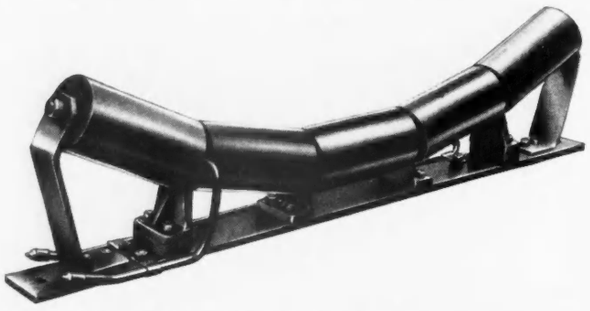

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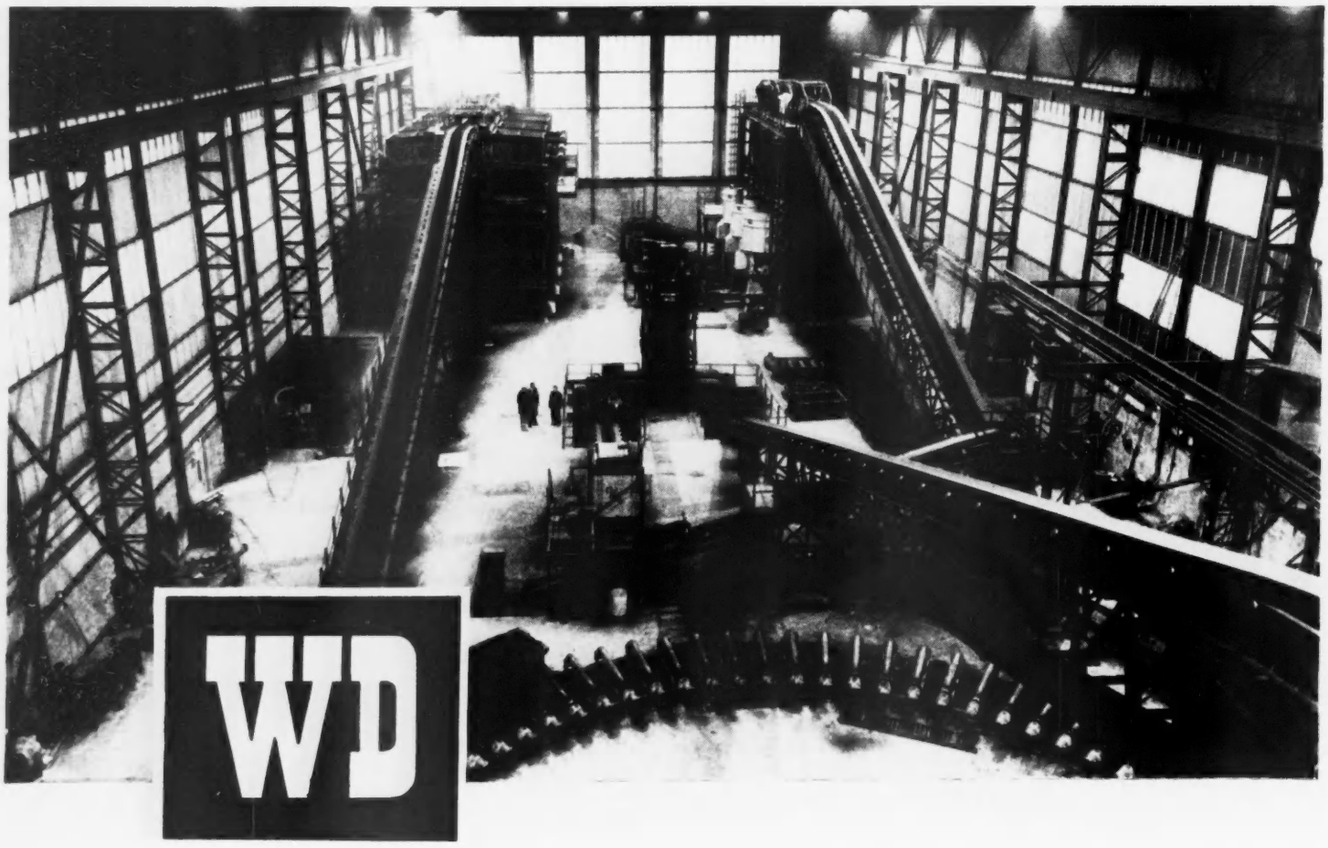

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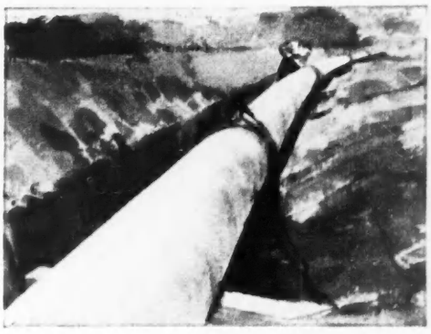

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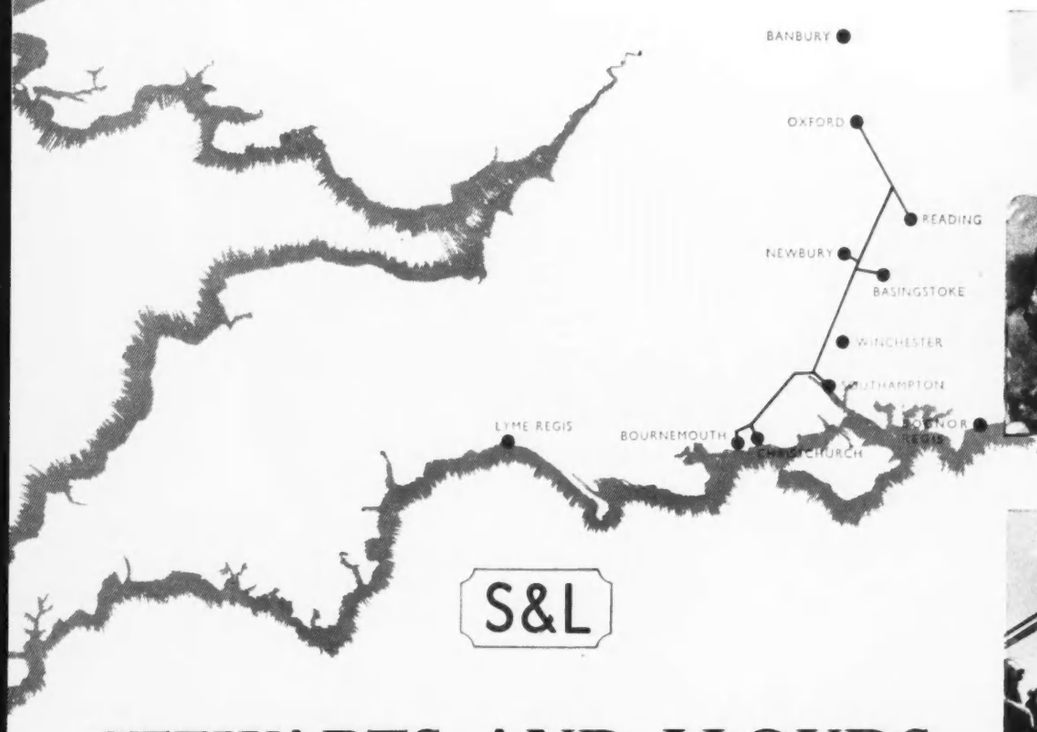

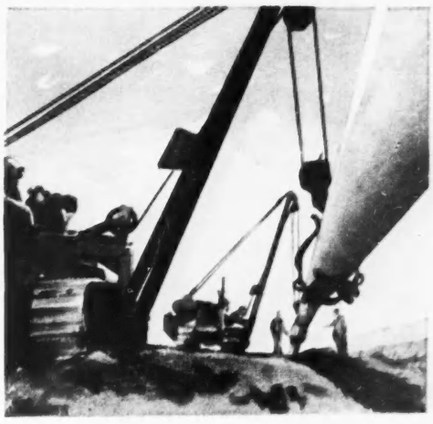

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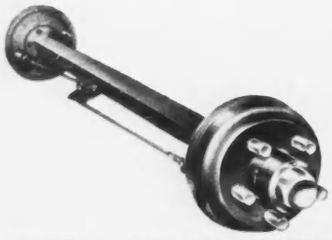

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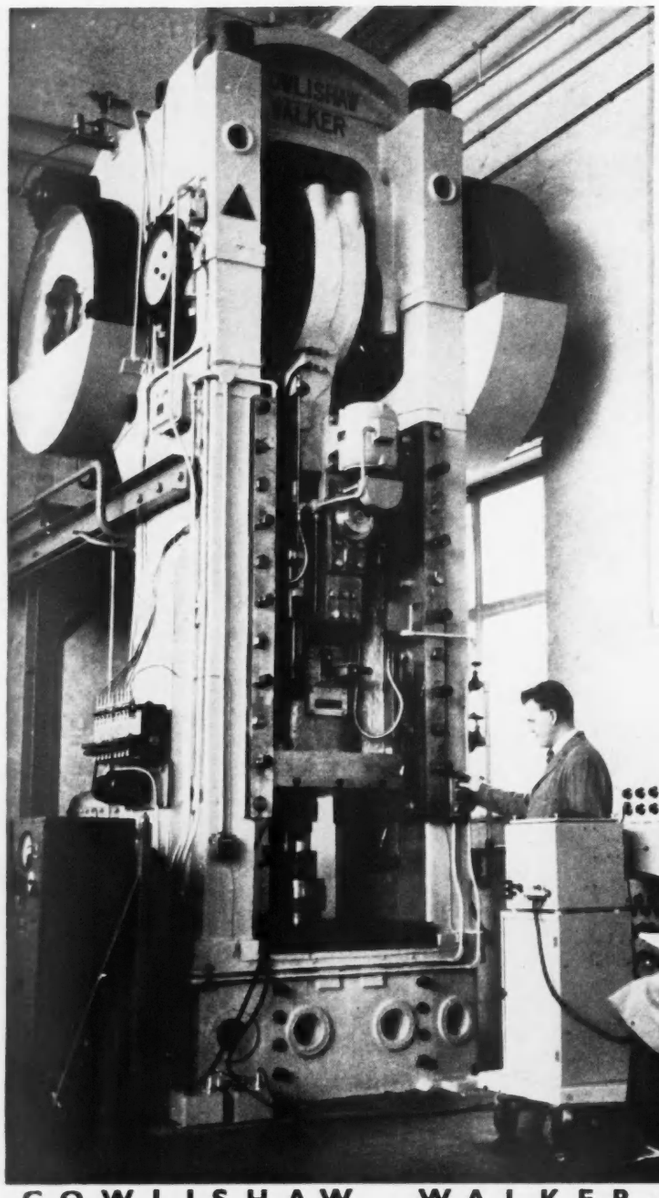

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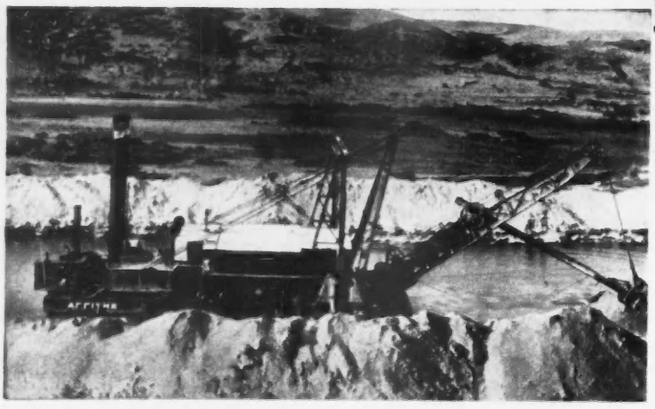

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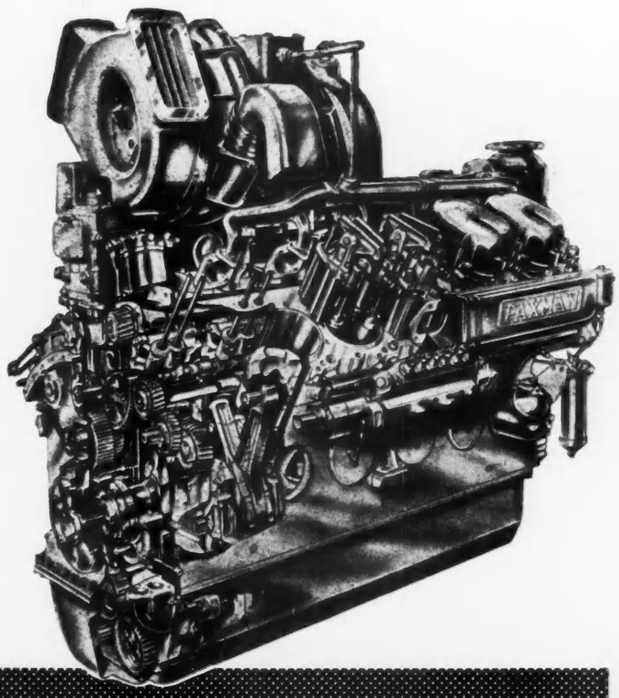

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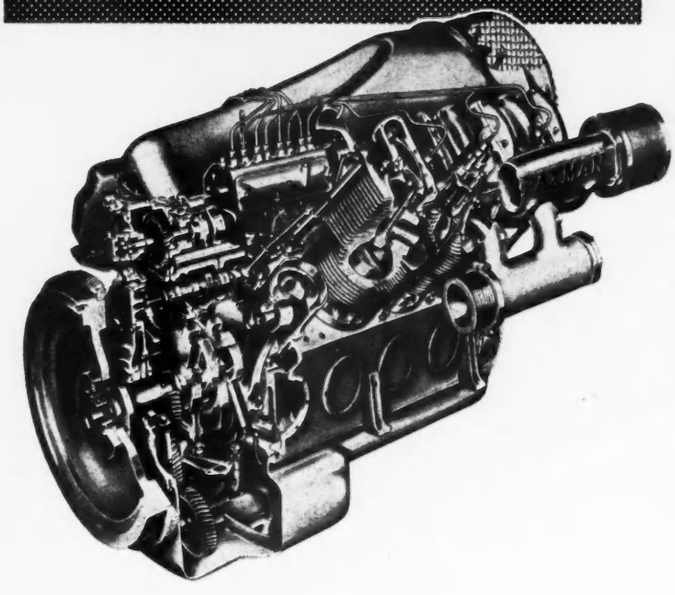

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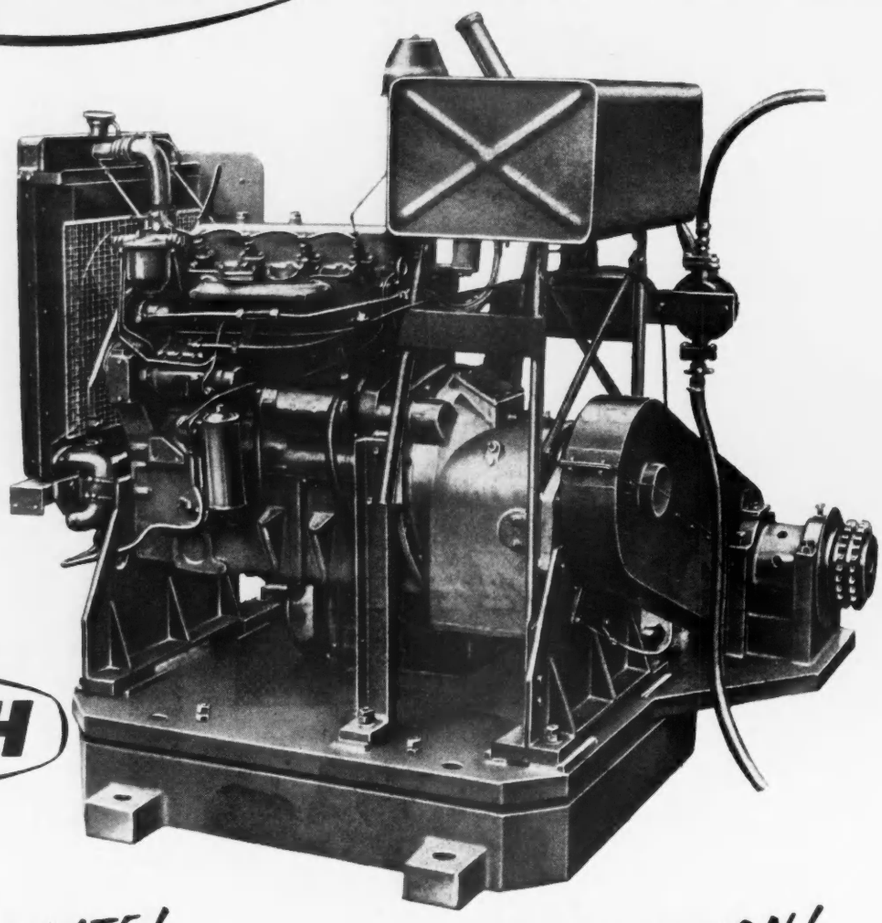

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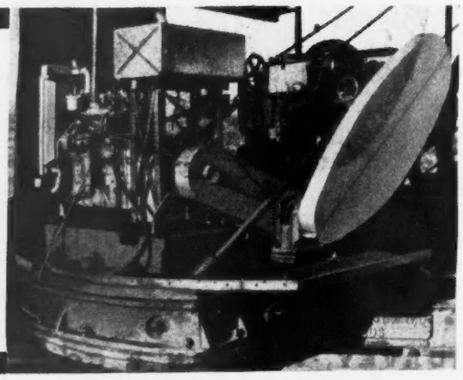

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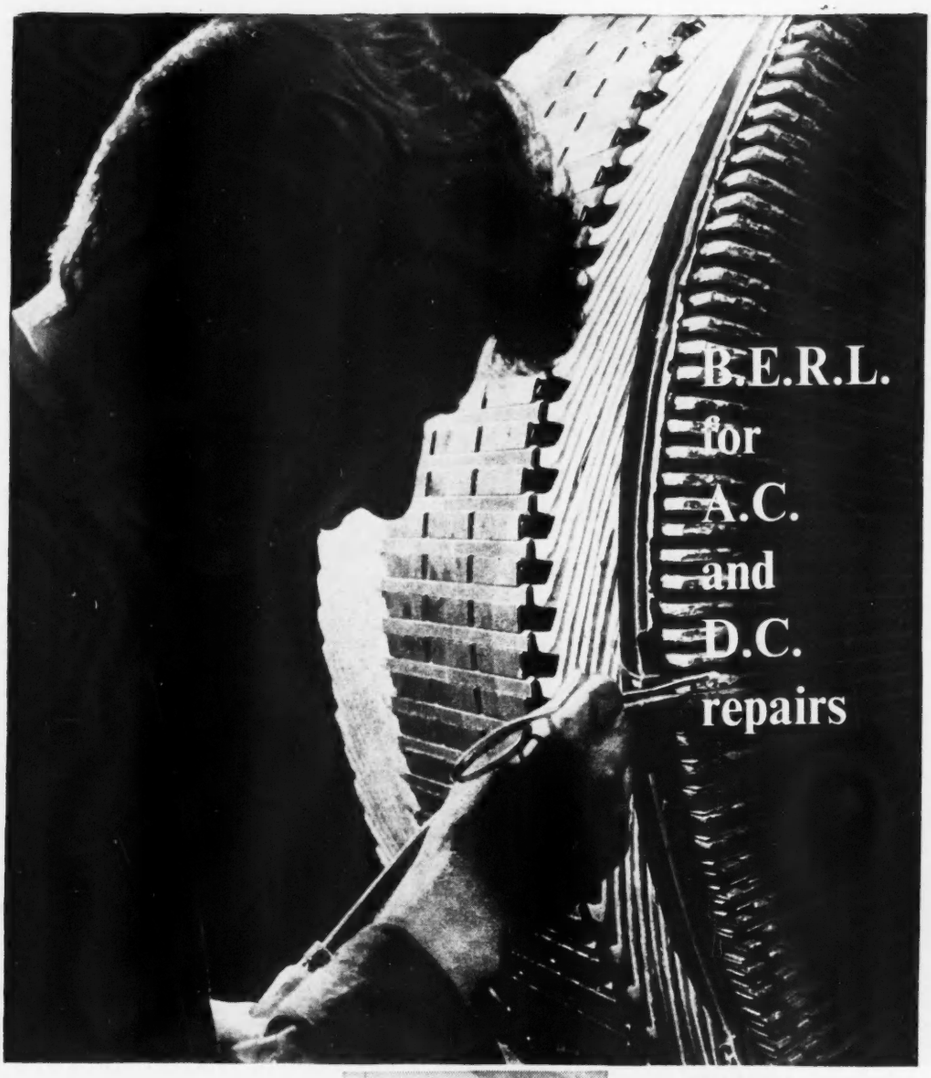

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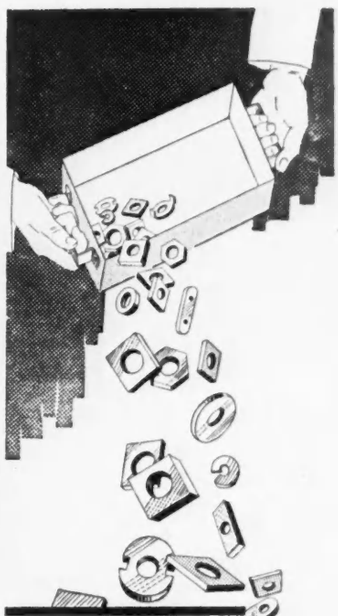

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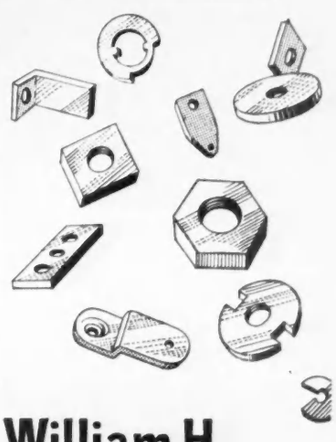

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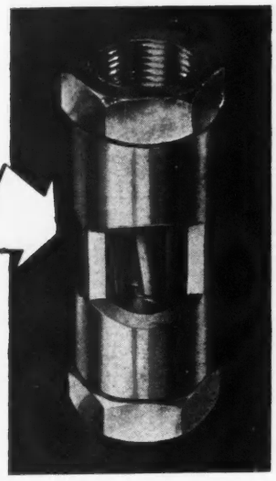

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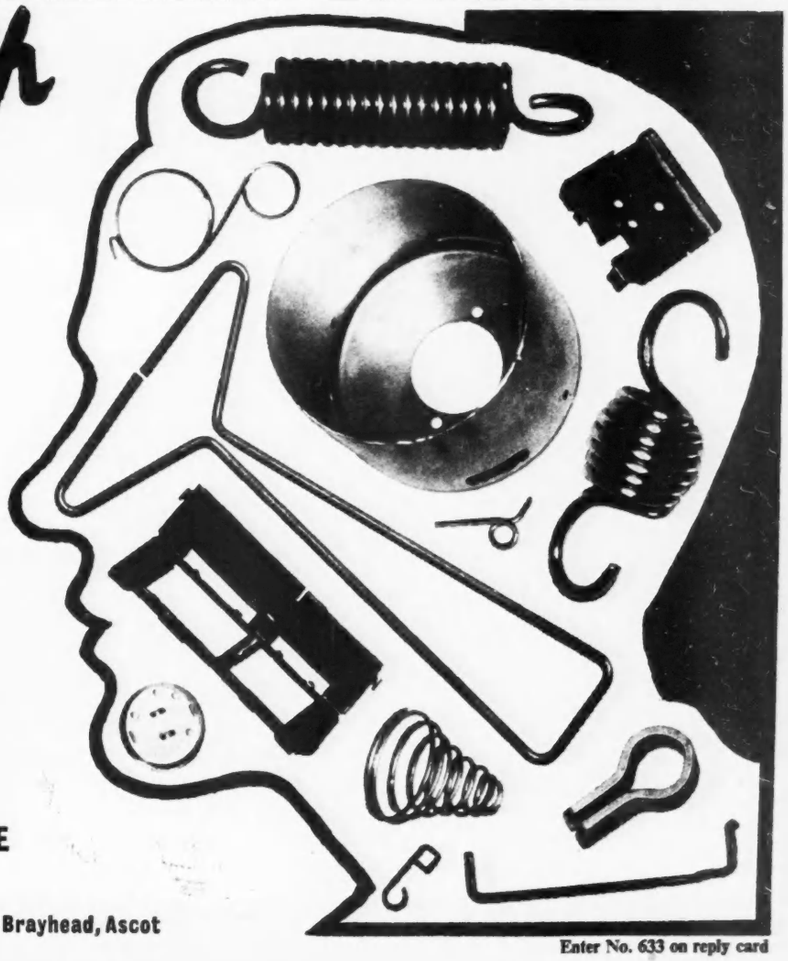

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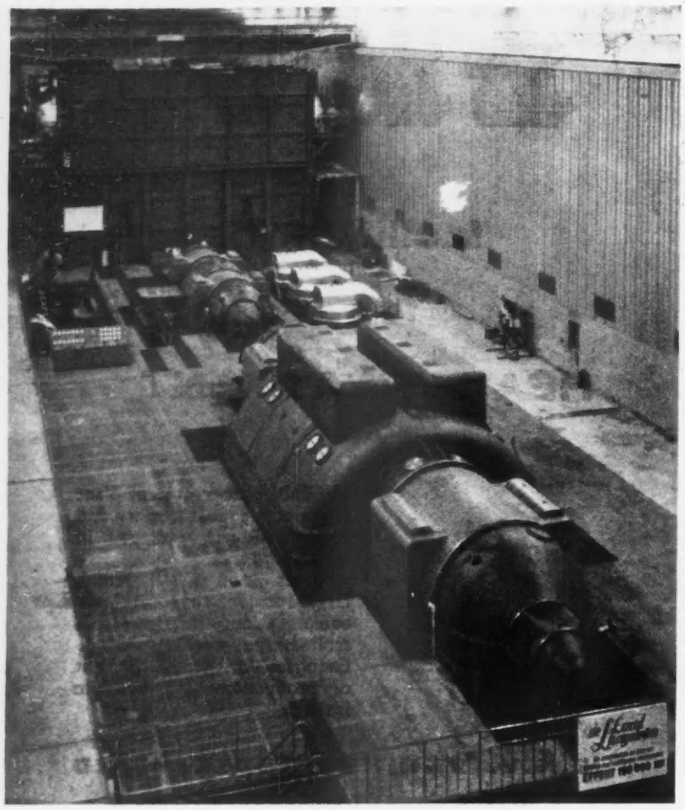

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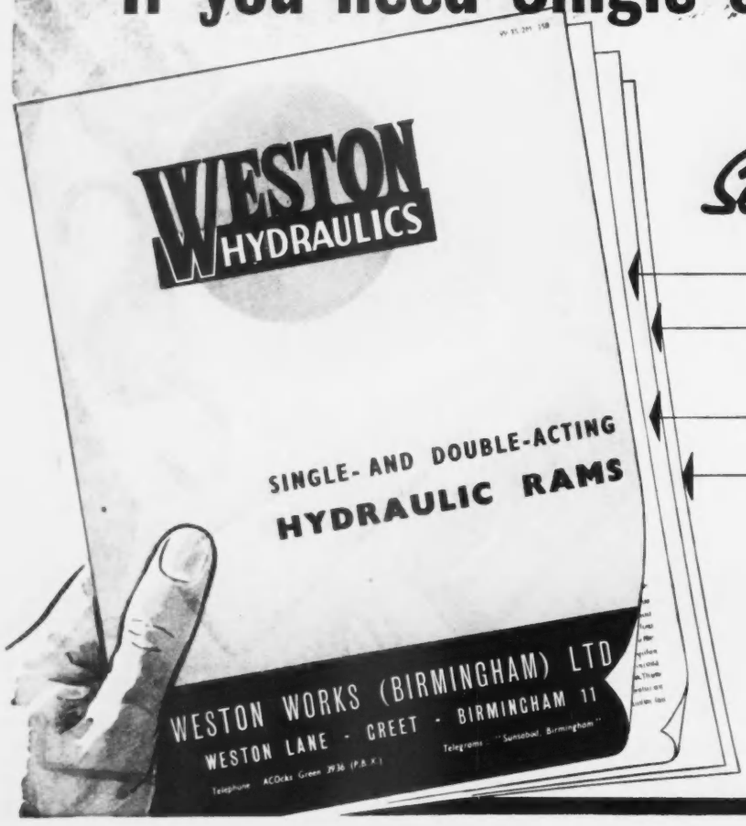

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THE ENGINEER

No. 5439 APRIL 22, 1960 VOL. 209

ABANDONMENT OF " BLUE STREAK "

It was implicit in this year's White Paper on Defence that the programme of developing the " Blue Streak " rocket as a weapon of war was about to be abandoned. We find it rather surprising, therefore, that the announcement last week that, in fact, it was to be abandoned, led to such a " row " in the House of Commons. But, no doubt, the event provided especially effective party ammunition. Blame was laid, and no doubt was deservedly laid, on the Government, because for months past (even years in the estimation of some) it has not listened to critics, such as ourselves, who have seen little value in static rocket emplacements and who have been pleading for a mobile sea-borne firing platform. Had the project been abandoned sooner, it can reasonably be argued, less money would have been " wasted " on it.

Yet we are not without sympathy for the Government ; because this is not the first time, nor we may be sure the last time, that what seemed a correct decision when it was made has been proved by unfolding events erroneous. If we wished to enter into a party political battle we might mention, as a recent example, ground-nuts ! We prefer to think only of engineering matters. Since the war there have been the apparent fiascos of the " Brabazon " and the " Princess " flying boats. Between the wars money was " wasted " on the production of those two airships, " R100 " and " R101," the latter of which crashed at Beauvais, in France, in 1930, soon after starting upon a journey to India, carrying with it the hopes of all airship advocates. One can think of similar miscalculations committed in the more distant past. There was Brunel's " Great Eastern," for instance. The history of engineering is studded with them; and never a year passes, we suspect, without some commercial concern quietly dropping expenditure upon the development of some device on which high hopes had originally been pinned. Whenever one is building for the future the risk must be accepted that it may turn out differently from expectations. In such circumstances critics always point out that such ill-starred projects ought to have been dropped earlier. But Governments and boards of directors, who have to take the unpleasant decision to admit they have been wrong, know also that they will have to do so in the teeth of opposition from people still convinced of the virtue of going on with the work !

It is, of course, always claimed that money has been " wasted " when a project is abandoned. But it is usually dubious whether it really has been. For invariably something and often a great deal is learnt from the attempt to make the project a success. Whether or not the addition to knowledge matches the expenditure is, of course, open to question in every case. In that of " Blue Streak " the loss may yet turn out much less extreme than it seems at present ; for there still remains a possibility that the rocket can be developed for space research. This country alone, we imagine, could not bear the cost. But now that " Blue Streak " is to be regarded no longer as a potential weapon of war there is presumably no objection to the sharing of knowledge about it with other countries. If so, there is the possibility that France and other West European countries might care to collaborate with Britain and the Commonwealth in developing a space research programme based upon " Blue Streak " and " Black Knight " and uninfluenced by warlike considerations.

SEE IT " IN THE ROUND "

Many years ago we remember seeing a film in which a twentieth century character discovered a number of rather melodramatic facts about the histories of a group of seventeenth century people who had, if we remember rightly, suffered shipwreck. From those facts he attempted to visualise the characters of the people concerned. At first he tended to divide them up into well-understood types ; the hero and the heroine invariably were to act heroically, the captain of the ship was to act always as every captain should and never make a wrong decision ; the villains were to be thoroughly bad, and the coward really cowardly. But this attempt at visualisation failed because the characters just would not come to life. Indeed, so lifeless were they that they were represented on the screen as transparent ghosts not even able to stand upright ! The twentieth century character then tried again ; and through a fine feat of imagination he did at last manage to see the seventeenth century characters " in the round." They became for him so real that he could, in imagination, converse with them—thereby creating the story of the film. Their actions, as represented in the somewhat melodramatic facts, became explicable. The captain turned out to be formidable but, judging by the events, not always wise ; the hero and the heroine became just ordinary mortals doing their best under conditions utterly strange to them ; the coward turned out to be not cowardly but gifted with just enough more intelligence than the rest to be able to foresee more clearly than they what was bound to happen ; and, as for the villains, there weren't any !

Now what, it may well be asked, has all this to do with engineering ? Lots ! For all of us in our professional and technical lives are faced by the same difficulty of seeing our problems "in the round." A current example springs to mind. Engineers have been crying out these several years past that the construction of motorways in cities has become essential. They have quoted figures to show how rapid is the growth in the number of vehicles needing to enter cities and how in London and other cities in this country traffic is already reduced to a chaotic state at times. They have used these arguments to draw the conclusions that motorways must come eventually and had best be laid out at once ; and these conclusions have seemed so obvious to them that they have been tempted to assume that only laziness and slackness (or, if not laziness and slackness, then something more shockingly immoral) prevents the Government and local authorities putting the work in hand at once. But if engineers look at the problem in that way they do so

" in the flat." They are thinking too much about the technical problem ; too little about the human side. By contrast, to an architect the driving of a motorway through a city centre is obnoxious ; it divides off the communities on each side of it from each other and has other defects in his eyes because it seems almost impossible to relate the buildings to it. The cost staggers Members of Parliament and local councillors. And local authority engineers and architects point out that even though city motorways are, no doubt, necessary, many of the facts are missing upon which it can be decided what routes they ought to follow. Delay may seem deplorable ; but clearly if action is going to be effective, these conflicts of opinion should be sorted out. The engineer should, at least, recognise that they exist even if he may be tempted to wonder whether the need to see things " in the round " may not here be used as an excuse for doing too little !

The need to see things clearly and " in the round " applies to many technical things, too. Of course, in design the need to see a problem fully " in the round " becomes extreme. There is very naturally a desire upon the part of engineers so to design something that it is technically a fine and an advanced solution to the problem. But, in fact, the technically advanced solution to the problem may not necessarily be as well-adapted to the end to be served as something a good deal more conservative. A preferable solution may be one that gives not the highest possible efficiency but the highest attainable economy in operation ; or the greatest reliability in service ; or the simplest possible maintenance ; or the cheapest production cost ; or which evades effectively a competitor's patent for a similar design ; or more probably an indistinct compromise amongst all those and other factors. It may be easy for a commentator in such circumstances, failing to see the matter properly " in the round," to criticise the resultant product and to impugn the " stupidity " of its designer. But if the product works well, and sells well against competition, then, whatever the critics say, the designers and makers can congratulate themselves upon the making of a really practical and useful device. It will be they and not the critics who have looked at the problem properly " in the round " ; they will be good engineers.

ADVISING ON BRITISH TRANSPORT

Before the House of Commons rose for the Easter recess, there was a debate on the special advisory group which, as reported in our last issue, has been appointed by the Government to examine the structure, finance and working of the organisations at present controlled by the British Transport Commission. The group is required to advise the Minister of Transport and the Commission, as a matter of urgency, as to how effect can best be given to the "Government's intentions" following a study of the Guillebaud report. Those intentions, it will be recalled, were indicated in a statement by the Prime Minister on March 10. In that statement, the Prime Minister said that the British Transport Commission must accept a radical alteration of its structure " so as to secure a more effective distribution of functions and a better use of all its assets." The detailed application of the measures required, the Prime Minister added, would be worked out by a " special planning board."

From the Minister of Transport's announcement on April 6, and last week's debate in the House, it appears that the " planning board " is now to be known as a " special advisory group." That does not matter very much. The four men so far appointed to it are possessed of technical and commercial abilities which they are ready to employ unsparingly in their complex assignment. The group will consult the British Transport Commission and the trade unions concerned in its operations ; its terms of reference, the Minister of Transport has emphasised, are wide ; it has no executive authority and it is not a committee of inquiry. But it is invited to tender advice quickly in order to assist the Government and the British Transport Commission to " deal with a situation which, unless it is dealt with now, will become steadily more serious." Primarily, of course, this " situation," as it was described in the debate, is a financial one. The Joint Parliamentary Secretary to the Ministry of Transport explained that the British Transport Commission's deficits to date amounted to £353 million and that, since 1956, the Government had advanced £276 million towards meeting these deficits. A further £326 million has been advanced by the Government by way of capital investment. Altogether, therefore, the Commission owes the Government about £600 million. It scarcely needs to be added that most of that debt falls under the heading of railway operations. Nevertheless, the Government realises, as does everybody else who pauses to think about the matter, that the debt must be settled ! The British Transport Commission is required by statute to operate efficiently the publicly-owned transport services and the Government has to see to it that the statutory obligations are fulfilled. If the advisory group decides, as a result of the examination on which it has already started, that the structure, finance and working of the British Transport Commission's organisations must be overhauled in the public interest, the Government and the Commission, we presume, will take the necessary action. The advisory group's task has been described as a " matter of urgency." The information so far made available does not give much indication of the likely results of that task. Our hope is that the advisory group's labours may be fruitful.

FUEL FOR CLEAN AIR

The Beaver Committee whose report on air pollution in 1954 led to the passing of the " Clean Air " Act in 1956 recognised that the burning of solid fuels by domestic consumers was a major factor in polluting the air above built-up areas ; and that therefore, if the nation was to have clean air, it would be necessary to expand the supplies of smokeless fuels and make it worth while for the domestic consumer to buy them. But at the time of the passing of the Clean Air Act there still remained a doubt as to whether enough smokeless fuel was being produced or could, within the near future, be produced to meet demands arising out of the creation of smoke control areas in any number. It seems quite probable that one of the reasons why the number of such areas so far designated has proved disappointing to clean air enthusiasts is a doubt in the minds of many local authorities about the adequacy of smokeless fuel supplies in the areas concerned. To illuminate the real situation the Minister of Power therefore appointed a small committee almost exactly a year ago to investigate " the availability and suitability of smokeless fuels and plans for their future production ; and the adequacy of present arrangements and future plans for their distribution."

The report of the committee on Solid Smokeless Fuels was published shortly before Easter by H.M. Stationery Office, and it is certainly enlightening in some ways. But the only really clear-cut conclusion which emerges from it is that the passing of the Clean Air Act does seem to have encouraged the manufacture of a number of new smokeless fuels under a variety of trade names ; and that still more such fuels are under development, perhaps so many as to prove confusing to the public. The committee

found it a matter of difficulty to estimate at all closely what will be the position in the future. If it were possible merely to add up all the supplies of smokeless fuels likely to be available and to equate them to an estimated total demand for such fuels due to a planned extension in the number of smoke control areas the situation would be clear enough. Looked at in that simple way there seems to be little likelihood of any shortage of suitable fuels. But in reality the situation is complicated by the fact that there are three main kinds of solid fuel burning appliances and several alternative means of house heating. Not all the fuels can be burnt on all the appliances. Some of them, notably coke, are not suitable for use with unimproved open grates. There are imponderables involved, such as the extent to which domestic users in smoke control areas might prefer to turn to gas or electric heating when they can no longer use raw coal ; and there is undoubtedly a growing tendency for central heating to be adopted, the last a factor of long-term rather than short-term importance. The committee comes to the rather tentative conclusion that there may be, in the more immediate future, a growing shortage of " specially reactive " fuels, that is, fuels suitable for use on unimproved grates ; and it therefore suggests that the Gas Council and the National Coal Board should consider increasing their production of such fuels. One of the reasons for the expected shortage is that people with improved grates often prefer fuels of this kind to the coke which such grates are well fitted to burn. Coke is unpopular for several reasons. It requires a larger storage space than other fuels, re-fuelling has to be done more often, and it is difficult to light unless the grate is fitted with a gas lighter device. Additionally in the past coke has been variable in quality. Upon that last point the committee was able to welcome an improvement. There is now a British Standard coke well suited to burning on open grates and the amount of coke being produced to that specification is increasing. All those who wish to see air pollution brought to an end will hope that this report will relieve the minds of any local authorities which may have deferred action for fear that supplies of suitable fuels will not be available.

AGREEMENTS IN THE AIR

Discussion at the Institution of Electrical Engineers' symposium before Easter on data handling and display systems for air traffic control turned at one time to methods of transmitting information from aircraft. At present aircraft generally notify their passage over reporting points by radiotelephone, but speakers in the discussion referred to various alternatives which would provide information in a form suitable for direct input to data handling equipment. One suggestion was that in the future there would have to be continuous reporting from the aircraft relative to time instead of reports related to arrival over specific points on the surface of the earth. The same speaker regarded an aircraft under control as part of a servo loop including the navigational system, communications to the ground, and back to the aircraft with a message to alter course. By planning along these lines one should establish the point at which it would be necessary to remove the human being from the loop because his reactions would be too slow for it. In further discussion it was emphasised that air traffic control was dealing with co-operating aircraft, and might therefore use airborne responder radar or pulse transmission systems, whereas present ground control radar had been developed from equipment designed to deal with aircraft which were the reverse of co-operative, and had to tolerate unwanted as well as wanted information.

Techniques such as the above can only be developed by international co-operation and agreement, and while they were being discussed a further step was taken in the highly controversial matter of standardising an air navigational aid. The Council of the International Civil Aviation Organisation decided on April 8 in favour of the adoption of the American VOR/DMET system as a standard short-range navigational system. Criticisms of the report on which this decision has been taken were referred to in our March 18 issue, and on April 4 the Minister of Aviation stated in a written answer to a Parliamentary question that he did not consider the conclusions the report sought to draw to be valid. Any decision of this kind is bound to disappoint some people, but at least its reasons should be made apparent to all concerned. In the present case it has not been shown satisfactorily that the British " Decca " is less accurate than the American system at short ranges—the maker claims that it is far more accurate and would allow a reduction in the width of airways—or that its co-ordinate system of defining fixes with reference to a hyperbolic grid is less convenient to the user than a range and bearing. We recently recorded the development of a computer which will convert these co-ordinates for identifying positions on a rectilinear grid. No consideration seems to have been given to the fact that the associated " Dectra " long-range system has some components in common with Decca so that provision for long-range and short-range fixing is made without complete duplication of equipment or installation of two entirely different systems. The whole situation emphasises the importance of early co-operation instead of parallel development and later controversy, and if some of the proposals at the I.E.E. symposium seem a little visionary at the moment, at least they have been put forward in good time to warn all concerned of present trends.

The Engineer—100 Years Ago (APRIL 20, 1860)

" Bitumenised Paper Pipes "

" The remarkable uses to which common paper is susceptible of being applied in the arts and manufactures, received a further novel illustration recently, in connection with some interesting experiments, made in London, having for their object the testing of a new kind of pipe or tube made of paper and bitumen, and intended to serve many of the purposes for which the metal tubes and pipes have hitherto been employed. The ingenious idea of hardening paper by means of an admixture of bitumen under the influence of hydraulic pressure, so as to convert it into a substitute for iron, is due to M. Jaloureau, of Paris, who was present, and explained his process. The world has already become familiar with the universal utility and value of papier mâché ; it has also heard recently that the Chinese constructed their cannon of prepared paper lined with copper . . . . but nothing probably has lately come before the British public in the way of paper so curious, and yet so commercially practicable and useful, as these bituminous paper pipes.

" The process of fabrication was fully explained, and the testing experiments, proved, to the surprise and satisfaction of all present, that the material, while it possessed all the tenacity of iron, with one-half its specific gravity, had double the strength of stoneware tubes, without, moreover, being liable to breakage, as in the case of other material, and which frequently causes a loss to the contractor of some 20 or 25 per cent. on the supply. In order to test their strength, two of these bituminous paper pipes of 5 in. bore and ¼ in. thick, were subjected to hydraulic power, and they sustained, without breaking or bursting, the enormous pressure of 220 lb. to the square inch, or equivalent to 506 ft. head of water, being double the actual pressure that the present London water-pipes of iron have to bear."

Kingsferry Lifting Bridge

Last Wednesday an opening ceremony was held at the Kingsferry bridge in Kent. The bridge has a lifting span which is carried by reinforced concrete towers, as is well shown by the accompanying aerial view. Our description is largely concentrated on the lifting span, and includes notes on the electrical equipment.

THE lifting bridge which crosses the River Swale and connects the Isle of Sheppey with the Kent mainland was officially inaugurated on April 20 by Her Royal Highness the Duchess of Kent. The accompanying illustration shows the old bridge which it replaces—a Scherzer rolling lift bridge—the new road approach and the old and new railway embankments on the Sheppey side.

There is apparently only one other major lifting bridge in this country, at Middlesbrough, and thus the main interest of the new bridge lies in the choice of this comparatively rare type, which in this case was found to be advantageous after comparison of designs for single and double-leaf bascule bridges and a swing bridge. As now constructed, the bridge has a lifting span which gives a 90ft channel for navigation, with 95ft headroom above high water. The lifting span is 120ft long and 50ft wide, carrying a 24ft carriageway, a single-line railway and a 6ft footpath. It is flanked by three steel approach spans on each side, giving a length of 650ft for the seven spans, and then there are approach embankments to give a total length of some 2500ft.

The site is on marshland and about 25ft of very soft clay overlies the stiff London clay, upon which the main structures are founded. At each of the two main piers, a large rectangular cofferdam, steel-sheet-piled and steel-braced, was built. Two shafts, 32ft in diameter—one corresponding to each tower of the bridge—were excavated in each of these cofferdams, down to a formation in the London clay. As sinking proceeded, concrete rings were cast *in situ* at the foot of the shaft and, finally, it was belled out at formation level which is about 60ft below H.W.O.S.T. The piers carrying the steel side spans rest on augured cast *in situ* cylinder piles 4ft in diameter, which extend to a level about 20ft lower than the main cylinders. The height of the approach embankments is limited to about 14ft by the softness of the surrounding ground. Thus, close to the seven spans of the bridge itself, the "abutments" consist of a hollow reinforced concrete construction carried on piles which can be seen in the illustration and extends over quite an appreciable length. A tunnel has been built under the Swale close to the bridge to carry a water main and other services.

The concrete towers, which are tapered, were built with purpose-made shutters so each shutter had four uses—one on each tower. A light steel tower was built ahead of the permanent tower and later dismantled. It carried a cathead with rails and pulley blocks and the shutters were handled by derricks and then by the blocks on the cathead. Concrete was brought up by a hoist in a tower of scaffolding.

The Lifting Span

The lifting span is of riveted and welded structural steel. It weighs 465 tons and its travel is guided at each tower by two vertical rails. The rails in each tower are side by side and there is a shoe on the span which slides along them and is shaped so that it also slides on the inner side of each rail, thus giving guidance in both longitudinal and transversal directions. When seated, the span is simply supported, with a concave steel bearing on the span resting on a corresponding cylindrically-shaped convex bearing on the pier at the "pinned" end, and flat and convex bearings at the free end. The clearance between the lifting span and the fixed span is of the order of 1in at the "pinned" end and the clearances at the shoes are of the same order. At the other end, however, where expansion can take place, the clearance may be slightly larger.

There is a counterweight of 110 tons in each of the four towers. Thus, an unbalanced weight of 25 tons is lifted; in addition, an extra weight of 20 tons can be lifted if necessary, this being the allowance for snow loading. The driving machinery is housed in each pier, in a machine room below the carriageway. The arrangement of this machinery is essentially simple. A variable-speed motor of 125 h.p. in each of the two machine rooms drives through reduction gearing, the latter being placed centrally and directly driving two winch drums. Each of these drums controls the lifting rope on its corresponding corner of the span. There is a synchronising tie between the two motors. Thus, the counterweights are carried directly through upper and lower sheaves at each tower and the hoisting rope is simply reeved from its winch drum to the tower and the span.

In normal operation the span is lifted in ninety seconds. It can also be lifted by two auxiliary motors, each of 17½ h.p., but this method of operation takes fifteen minutes; either mains power or a stand-by diesel engine can be employed. In normal operation, control of the lifting sequence is entirely automatic with comprehensive interlocks, as is explained further on.

When the span is being lowered on to its bearings, the first contact is made by hydraulic buffers mounted on the span, of which there are two at each end. Transverse alignment is obtained to an accuracy of $\frac{1}{16}$in. At the

Kingsferry lifting bridge

" pinned " bearing the cylindrically-shaped bearing surface on the pier has a notch cut in it, transversely. A steel wedge on the lifting span engages in this notch. At the " roller " end, cheeks on the sides of the upper bearings have the same function, engaging the machined edges of the lower bearings. Since the clearances at the shoes are substantial in relation to the transverse tolerance, the span may actually move down the last inch of its travel at an angle of 70 deg., as the wedge and notch engage, and should, for instance, a side wind be blowing. When the span is down, its position is " proved " by locking pins which are pushed from the piers into the end girders of the lifting span.

This arrangement for transverse alignment is relied upon to line up the rail track. The layout at the rail break makes use very largely of standard pieces of permanent-way equipment. A " fishing rail " projects 18in beyond the end of the lifting span, on the outer side of each rail. Its inner side is machined at 70 deg. for the top 1in, corresponding to the possible limit of movement of the span as just explained, and the mating face of the fixed rail is similarly shaped. Below the 1in of 70 deg. taper, the fishing rail is still tapered but not so sharply. Thus the fishing rail takes no load as the span is brought down, but nevertheless finishes up accurately in position. Its top surface is intended to carry the tyres of vehicles as they travel over the break, and is thus level, at the rail level, over a distance of 3in at the break, and then tapered downwards on either side. There are two other devices at the rail break, namely, a contact for track circuiting and earth return, and a plunger switch for the signalling. These two devices also, by means of lever mechanisms, prove that the rails are correct for level to within approximately $\frac{1}{8}$in. Furthermore, the rail signalling is interlocked with the bridge bolts, which also prove that the bridge is level for railway use.

Electrical Equipment

The main hoisting machinery of the bridge gives a maximum lifting speed of approximately 64ft per minute thereby lifting the span in one-and-a-half minutes, with the two 125 h.p. d.c. motors. These two motors in addition to the normal commutator are fitted with sliprings, the sliprings being connected together to form a synchronous tie. The armatures of these two motors are supplied from a common generator working on the Ward Leonard principle, constant torque thereby being available over the entire 16 to 1 speed range.

The two standby motors, each of 17½ h.p., are slipring induction machines also connected to provide a synchronous tie. These machines have no speed range ; they lift the span in approximately sixteen minutes, i.e. the maximum lifting speed is some 5ft 6in per minute.

The main incoming switchboard is in the island side machinery room, power being taken at 415V, 50 c/s, four-wire. This switchboard comprises a three-panel arrangement, all switches being electrically operated from the main control desk on the mainland side.

Standby battery equipment is installed in the mainland side machinery room, and comprises control panel together with a battery cabinet. The " Nife Never-Fayle " equipment maintains a 230V emergency supply of 2·5kW, for a period of one hour. This battery is used as a standby source of supply for all indication lighting and a small amount of essential lighting throughout the bridge together with various essential control circuits.

TABLE—*Main Sequence of Events in Raising Bridge from Control Desk, Using Main Motors*

Move controller to position given below	Change in desk indication	Change in state of bridge
1. Turn Castell key to release position	None	Controllers now free
2. Road lights red	Red " road light " illuminated. Green " road light " extinguished	Flashing beacons and advance warning signs showing
3. Close road gates	Red " gates closed " illuminated. Green " gates open " extinguished	Warning bells ring, road gates close
4. Open locking bolt	Red " bolt out " illuminated. Green " bolt in " extinguished	Locking bolts withdrawn from lifting span
5. Low speed hoist	Red " motor brakes off " illuminated, Amber " slow." Green " motor brakes on " extinguished. Blue " levelling operative " illuminated	Brakes released. Bridge lifting at slow speed
6. High speed hoist	Red " fast " illuminated. Amber " slow " extinguished	Bridge accelerates to high speed
7. Navigation lights green	Green " navigation light " illuminated. Red " navigation light " extinguished. Red " motor brakes off " extinguished. Green " motor brakes on " illuminated	Navigation lights change to green, and the bridge is now open to shipping

Normally the controller would be moved right round to the " navigation lights green " position when steps 1, 2, 3, 4, 5, and 6 would be passed through automatically.

The main contactor panel is in the mainland side machinery room. Whilst this panel can be regarded as the main portion of the control equipment for operational purposes, the panel is split into two separate sections, namely, power supplies and heating and lighting supplies. The two sections are housed in a common enclosure, but are electrically independent of each other, it being possible to operate both from the same source of supply, or alternatively from two separate sources of supply.

The air-cooled diesel-alternator set is in the mainland side machinery room together with a wall-mounted local control panel. It is controlled by push-buttons on the control desk or the local panel. The alternator is self-excited and will build up its voltage automatically. The rating of the alternator is 55kVA, 40kW, 415V, three-phase, 50 c/s, sufficient to supply the two 17½ h.p. emergency hoisting motors, or alternatively to supply the normal heating and lighting requirements of the bridge, but not both simultaneously.

Motors operating the road gates and locking bolts are positioned next to the gates and the bolts. They are 1½ h.p., a.c., squirrel-cage rotor machines.

The main control desk is mounted in the control room, where a good view of the bridge is obtained. To the left of the desk, mounted on the wall between two windows, is the breakdown control panel. This panel will be used if it should prove necessary to hoist the bridge if the road gates have been damaged or the normal sequence interlocking circuitry has been rendered inoperative.

At all other times, however, the main control desk covers all the various sequences needed to operate the bridge. Each stage is indicated on the desk by red and green lights. The main operation is controlled by a lever, " the controller," which can be set in seven positions, and is provided in duplicate on the desk. It is locked in the closed position by a Castell lock.

Preliminary operation involves pressing certain buttons to establish the power supply to be used, and whether the main or auxiliary motors are to be operative. Each stage is indicated by green lights, when it is functioning correctly. The bridge must then be released from railway interlocks. The operator telephones Sittingbourne signalbox and requests this release, then sets a switch to " release taken," which is again indicated by a green light on the main sequence of the desk. At this stage the main sequence of operations is commenced as listed in the table above.

It may be of interest to the reader to compare the description given above with the data on the lifting bridges of the St. Lawrence Seaway, published in THE ENGINEER of June 19 last. The lifting bridge at St. Lambert lock is fairly closely comparable, having a span of 108ft against the 120ft of Kingsferry bridge. The height of lift of the Canadian bridge is rather higher, and the disposition of machinery is different because of the lock which it serves. The difference in appearance between the two is striking, and it is evident that the concrete towers of the Kingsferry bridge are visually very successful. In fairness to the Canadian bridge, however, it must be pointed out that it is at the end of a long steel-trussed bridge which crosses the St. Lawrence river, whereas the Kingsferry bridge is a landmark in a vast expanse of flat countryside.

The Canadian bridge is completely counterbalanced, and is lifted by not much more than half the horsepower installed at Kingsferry, where a preponderance of 25 tons is maintained. But the " spanlocks " of the Canadian bridge have been dispensed with at Kingsferry, and the gap is 1in as against 3in on the Canadian bridge. An even more marked difference, however, lies in the treatment of the rail breaks. The Canadian bridge, where rail traffic is very heavy, has quite an elaborate mechanism at the break, whereby a wedge is inserted, followed by a proving bolt, to give positive indication of true alignment of the rails. The arrangement at Kingsferry is, by contrast, quite simple.

Firms at Kingsferry

The Kingsferry bridge has been built for the Kent County Council. The consulting engineers were Messrs. Mott, Hay and Anderson. The main contractor was John Howard and Co., Ltd., and the steelwork sub-contractor was Dorman Long and Co., Ltd. The contractor for the lifting machinery was Sir William Arrol and Co., Ltd., and the contractor for the electrical equipment and the automatic control gear was Lancashire Dynamo and Crypto, Ltd.

The approach roads were built by direct labour by the County Surveyor of Kent, Mr. H. Bowdler, M.I.C.E., and the detailed arrangements for the permanent-way and signalling were the responsibility of the Southern Region of British Railways. The cost of the bridge was £1,380,810, and the construction time was twenty-seven months.

" BASIC ROAD STATISTICS."—Salient statistical facts are again recorded in the 1959 edition of the British Road Federation's " Basic Road Statistics." Great Britain has more vehicles per mile of road than any other country—29·0. West Germany is second with 21·9. This figure includes cars, buses, coaches and goods vehicles only ; if motor-cycles, Government-owned vehicles, and those exempt from taxation, are added the British figure is 41·3 vehicles per mile of road. On the basis of ton-mileage, 45 per cent of goods are carried by road compared with 35 per cent by rail. By weight, 76 per cent go by road and 19 per cent by rail. " Basic Road Statistics " brings together the latest figures from numerous official sources, and is widely used as a standard reference on all essential road matters.

Rules and Regulations for Structural Steelwork

By A. N. PROCTER, M.Sc., A.M.I.C.E., M.I.Struct.E.

British structural steelwork regulations are wasteful and inefficient. This defect is reflected in the inability of steelwork to compete with modern forms of construction. The old and uneconomical methods of design at present enforced are briefly considered. Some alternative ideas and formulæ are suggested.

PROGRESS in the development of structural steelwork has been much retarded by official rules and regulations during the past half-century. Prior to that, engineers and architects had full liberty to use their own methods of design and specification. The year 1959, however, marked the passing of the control of the design of structural steelwork entirely into the hands of the British Standards Institution ; so that there is reduced hope of any reasonable future progress in this branch of British engineering.

Current British Standards Specifications, namely, B.S. 153 : 1956, "Steel Girder Bridges," and B.S. 449 : 1959, "The Use of Structural Steelwork in Buildings," give too much attention to details at the expense of general guiding principles. The result is an overall restriction of the development of progressive and economic ideas. Thus, designers and engineers are forced to use a B.S. Specification as a kind of text-book on design, in preference to the latest available technical improvements and data.

It is quite proper for public authorities to adopt by-laws regulating minimum load-carrying capacities of floors, &c., in buildings. Some ruling as to minimum load factors to be used for various classes of structural materials, methods of construction, &c., is also desirable. The remainder could quite properly be left to the discretion of those responsible for the supervision and construction. This would encourage commercial research and development, enabling British engineers to regain their lead and tender more successfully for foreign projects.

Working Stresses

Permissible stresses in B.S. 153 and B.S. 449 have increased progressively during the past thirty years. There have not, however, been corresponding improvements in the approved methods of designing the ordinary beams and columns that form the bulk of steelwork used for buildings.

For maximum economy, the design stresses should be selected with reference to the working conditions. Steelwork carrying only dead loads, fabricated and erected under good conditions, might be designed to a low-load factor. A higher factor is obviously required when there is mainly imposed loading, together with corrosion, fatigue and poor site conditions. The added strength of concrete casings could be determined with advantage by direct calculation, in preference to the rough-and-ready methods now enforced.

The tabulated column stresses at slenderness ratio $l/r=0$ have load factors of 1·69, rising to 3·0 at $l/r=100$ and gradually decreasing to 2·1 at $l/r=350$. The load factor is unofficially declared to be 2·0. Further to this, the effective column length coefficients contain load factors varying between 1·0 and 1·47 and the empirical method of combining axial and bending stresses introduces another load factor that may be as much as 1·4 to 1·5. Thus, the overall load factor on slender columns is usually not less than 4·0 at $l/r>140$, about 3·5 at $l/r=100$ and at $l/r>20$ about 2·25.

As an alternative, it is evident that for slender columns a formula of the simple form Constant$/(l/r)^2$ is correct. It gives a uniform load factor up to the Euler limit. This, for rolled steel sections, is at about $l/r=100$. Between that point and $l/r=$zero the formula of a straight line or a simple curve could be used (diagram and Table I).

TABLE I—*Safe Stresses in Mild Steel Columns With Ends Free*

$\frac{l}{r}$	Safe stress		$\frac{l}{r}$	Safe stress
	Straight line	Parabola		
0	9·40	9·40	110	5·29
5	9·25	9·39	120	4·45
10	9·10	9·37	130	3·79
15	8·95	9·33	140	3·27
20	8·80	9·28	150	2·85
25	8·65	9·21	160	2·41
30	8·50	9·13	170	2·21
35	8·35	9·03	180	1·98
40	8·20	8·92	190	1·77
45	8·05	8·79	200	1·60
50	7·90	8·65	210	1·45
55	7·75	8·49	220	1·32
60	7·60	8·32	230	1·21
65	7·45	8·13	240	1·11
70	7·30	7·93	250	1·02
75	7·15	7·71	260	0·95
80	7·00	7·48	270	0·88
85	6·85	7·23	280	0·82
90	6·70	6·97	290	0·76
95	6·55	6·70	300	0·71
100	6·40	6·40	350	0·52

$E=13{,}000$ tons per square inch. Y.P. = 16 tons per square inch.

The results of more than a century of laboratory tests show that for columns with both ends free : with one end fixed and one end free (in direction) ; and with both ends fixed or flat ; the effective lengths should be in the ratios 1 : 0·71 : 0·58 and not 1 : 0·85 : 0·7 as at present enforced. These improvements would both be advantageous.

Steel Frame Design

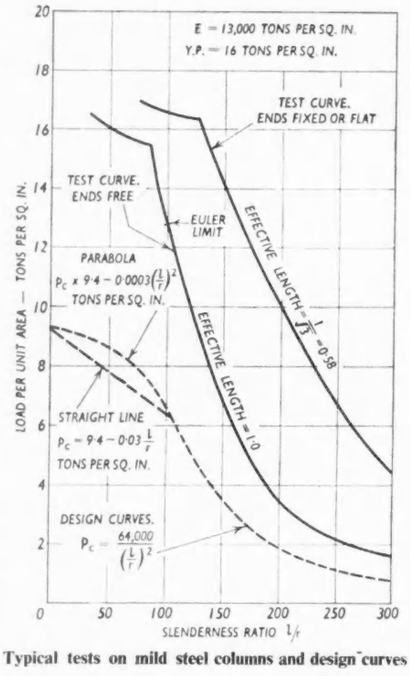
Under the current B.S. 449 it is found that what is known as the simple method of design is best for most projects. This employs a general assumption of independent columns and simply supported beams. Nevertheless, many beam to column connections are considered capable of fixing in direction or of restraining the columns. Obviously all such connections must in practice partially restrain the ends of the beams and so transmit to the columns end-moments that are ignored in the design.

Even though the connections may not be rigid, a sufficiently accurate value of the end-moments could be estimated without making a complicated analysis of the framework. The moments could then be distributed to the adjacent members by a method similar to that used in C.P. 114, "The Use of Reinforced Concrete in Buildings."

There would evidently be some reduction of the calculated bending moments in the beams and increased moments in the columns. The first would give an economy in the beams. The last could be provided for in the calculations by making much needed improvements in the method of designing the columns. If this were not so, the columns used to-day are too small. Surely the disregarded end-moments would in many cases cause them to be seriously overstressed, were the present method of design correct.

The regulations recommend a semi-rigid method of design[1] that was devised about a quarter of a century ago, but the columns under these conditions would be too heavy owing to the big load factor required. The saving that is made on the beams is thus lost on the columns and no advantage gained.

The use of "plastic" designs is referred to in B.S. 449 : 1959 (clause 9 (*b*)). This method was developed by Professor J. F. Baker from the "bending paradox" introduced by Professors P. Barlow and E. Hodgkinson in 1855.[4] The theory applies only to materials after they are overstressed beyond the proportional limit, so that repeated or reversed loading could have a serious effect, unless there is a satisfactory load factor. B.S. 449 does not suggest a load factor, but limits the deflection of the beams. Without a load factor "plastic" designs cannot be made.



Typical tests on mild steel columns and design curves

The "plastic" section moduli of R.S.J.s are greater than the elastic moduli and may be estimated with reasonable accuracy. Dr. E. Volterra (1943)[5] found, however, that calculated "plastic" moduli of some sections were considerably in excess of his experimental values. It appears, therefore, that official tables of the correct plastic properties of B.S. sections should be published. Correct torsion constants of B.S. sections are badly needed, too.

Beams and Girders

Apart from the small saving that is permitted by using the special methods of designing the beams, attention has been mainly directed to the buckling of the flanges and webs of beams and girders. The design of laterally unsupported beams was formerly a matter of a simple formula. Now it has become a complicated affair of tables and rules, unfortunately based on ideas that are quite out of date.[2]

The basic formula for the buckling stress of a beam may be reduced to the simple form constant × form factor$/(l/r)$. The exact value of the form factor would be obtained from

$$\sqrt{\text{Area} \times \text{torsion constant}}/\text{section modulus.}$$

Since the torsion constant is not usually tabulated, it may be represented by area $\times t_1^2 \times$ coefficient, t_1 being the average flange thickness. The form factor then becomes area $\times t_1 \times$ coefficient/section modulus, or $u \times t_1 \times$ coefficient/r_1^2, where u is the distance of the compression flange from the neutral axis and r_1 is the radius of gyration about the xx axis. Exact values of the form factor for rolled sections and plated sections often in use may be tabulated (Table II). Using a load factor of 2 or a

TABLE II—*Laterally Unsupported R.S. Beams*
Form factors (corrected for transverse deflection)

Size in inches	Lb/ft	Form factor	Size in inches	Lb/ft	Form factor
24×7½	95	0·073	10×8	55	0·120
22×7	75	0·067	10×6	40	0·115
20×7½	89	0·089	10×5	30	0·095
20×6½	65	0·070	10×4½	25	0·087
18×8	60	0·086	9×7	50	0·145
18×7	75	0·090	9×4	21	0·090
18×6	55	0·072	8×6	35	0·128
16×8	75	0·095	8×5	28	0·115
16×6	62	0·095	8×4	18	0·087
16×6	50	0·078	7×4	16	0·095
15×6	45	0·074	6×5	25	0·145
15×5	42	0·079	6×4½	20	0·130
14×8	70	0·105	6×3	12	0·106
14×6	57	0·108	5×4½	20	0·168
14×6	46	0·086	4½×1½	6·5	0·120
13×5	35	0·080	4×3	10	0·150
12×8	65	0·120	4×1½	5	0·111
12×6	54	0·125	3×3	8·5	0·165
12×6	44	0·102	3×1½	4	0·148
12×5	32	0·080			

$E = 13{,}000$ tons per square inch. Safe stress $= \frac{E}{l/r_z} \times$ form factor.

little more, the safe stress may be quickly and easily calculated without the use of tabulated stresses.

To introduce into the formula the hypothetical effect of the flange warping is inadvisable. There is no guarantee of the experimental correctness of this adjustment. Moreover, there are other matters of greater importance that have been ignored. The effect of the load carried on the top flange and the effect of riveted flanges are among these. The first may now be calculated if required by deducting

$$\frac{\text{Euler stress}}{\text{Load factor}}\left(1-\frac{2u}{t_1}\frac{r}{l}\right)/1{\cdot}2$$

or safe column stress (approximately). The use of the ratio of beam depth/flange thickness is inadvisable, since it would apply only to the shape of section for which it is derived, e.g. an "I" beam.[2] If then used for a different shape such as a built-up gantry girder, the error may be 30 to 40 per cent. This would apply also to angles and tees.

Compression Members

The B.S. clauses governing the design of compression members are now very much behind the times. Reference has been made to the inefficiency of the column formula and effective length coefficients, all of which should be discarded. The design formula is based on a misconception of the combined action of axial forces and bending moments on "I" beams and other structural shapes and of the mode of failure.

When there is no torsion applied to a member, the theoretical relationship between the axial force, F_A, the bending moments, M_x and M_y, and the Euler[3] load P_y, is given with sufficient accuracy by :

$$F_A + \frac{\beta M_y}{y_o} + \frac{(\lambda M_x)^2}{GI_T} = P_y$$

GI_T being the torsional stiffness of the member, y_o the maximum deflection produced by all bending moments and forces, β and λ coefficients, thus :

$$\frac{FA}{P_y} + \frac{\beta M_y}{y_o P_y} + \frac{(\gamma M_x)^2}{P_y GI_T} = 1$$

If M_B is the bending moment applied about yy axis that would itself cause a deflection y_o, it can be shown that

$$M_B = y_o P_y/\beta \text{ putting } M^2{}_L = \frac{1}{\lambda^2} P_y GI_T$$

the formula becomes :

$$\frac{F_A}{P_y} + \frac{M_y}{M_B} + \left(\frac{M_x}{M_L}\right)^2 = 1.$$

Thus it is clear that the design formula should be :

$$\frac{f_c}{p_c} + \frac{f_y}{\gamma p_b} + \left(\frac{f_x}{p_1}\right)^2 \leq 1$$

where f_c, f_y and f_x are the axial and bending stresses and p_c, p_b and p_1 are the permissible stresses in columns, beams and laterally unsupported beams, giving reasonable results for steel columns. The coefficient γ used for plastic design is 1·4 for R.S.J.s.

In the tip of one flange of a deflected member there might be a concentration of stress that may cause local overstrain or local buckling, should the maximum applied bending moments occur at the same point. The total combined stress would amount to :

$$f_c + f_x + f_y \Big/ \left(1 - \frac{f_c}{p_e} - \left(\frac{f_x}{p_z}\right)^2\right) = f_{max}.$$

p_e being the Euler stress and p_z the torsional flexural buckling stress. f_{max} should not exceed the maximum permissible local stress.

Effect of Torsion

If there is also a torque acting on any member that carries buckling forces and moments, it can be shown that the design formula would then be :

$$\frac{f_c}{p_c} + \frac{f_y}{\gamma p_b} + \left(\frac{f_x}{p_1} + \frac{f_s}{p_s}\right)^2 \leq 1$$

where f_s and p_s are the maximum calculated and permissible shear stresses caused by torsion.

Should the member be a laterally unsupported beam that carries an eccentric load or a beam that is curved in plan, the formula would be applicable ($f_c = 0$). It may also be adjusted to suit other combinations of circumstances to meet the requirements of modern structural steelwork.

Conclusions

The advantages of welded steelwork construction are slowly but surely gaining recognition. Not only does it mean appreciable saving of material, but it ensures a much greater rigidity of all types of structures, when it is properly applied.

Before the days of detailed steelwork regulations, it was possible for enterprising engineers to erect structures of light and economical designs that have since passed the test of time. Now all are obliged to design heavy, unshapely structures that are unpleasing to the eye, uneconomical and often quite uncompetitive.

Structures for power stations, factories, workshops, aerodromes, long and medium span bridges, installations for electric power lines and electrification of railways, and structures for a very wide range of purposes are all open to the choice of a number of forms of construction. Properly designed steelwork is competitive and has the advantage of a light and pleasing appearance, in contrast to the larger cross-sections required by all other materials of construction.

Standard design will prevent engineers from exploiting to the full the many advantages of this excellent form of construction. It is bound to do more harm than good, at a time when the national industrial prosperity to so large an extent depends on the enterprise and ingenuity of engineers and designers.

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Exploitation of Minerals for Mankind

By I. W. WARK, Ph.D. (London), D.Sc. (Melbourne)*

Here we reprint some extracts from the fifth Sir Julius Wernher Memorial Lecture presented to the Institution of Mining and Metallurgy on April 6. Much of what Dr. Wark had to say was of interest only to those specially concerned in mineralogical work. We have chosen to print, however, certain sections of his lecture that have a wider interest in that although the particular reference is to the work of Dr. Wark's Organisation, engineers will easily see relevance to aspects of their own work.

IN exploiting its mineral resources, Australia has benefited enormously from the rest of the world. However, because of its large size and small population and because of its youth as an industrial nation, it faces a host of problems whose solutions do not exactly parallel those found effective in older countries. I am therefore hopeful that my audience may find something of interest in an account of what is being attempted on the other side of the world. However, at the outset it may be of value to consider certain problems common to all the mineral-processing countries throughout the world.

The American magazine *Fortune* for January, 1959, has emphasised that the lag in developing suitable inorganic materials—metals, alloys and cermets, for example—is the most important single bar to progress in the utilisation of atomic power. From an analysis of the situation it draws what I think a correct conclusion, viz. that no sensational advances can be expected until development is guided by deeper scientific understanding. *Fortune* goes on to point out that competitive materials—the organic polymers, for instance—are very strongly supported by fundamental research. It then predicts that plastics will take over more and more jobs now performed by metals. There follows the claim that the most promising metallurgical work is being done by chemical and electrical companies and in governmental laboratories.

Why is it that metallurgical research—the life-blood of future production in the mineral industry—lags in comparison with chemical and electronic research? It is certainly not because mining and metallurgical men lack vision or courage; they are in fact among the most sagacious and adventurous of the industrialists. May I suggest two possible explanations. The first is that a company depending on a wasting asset—a mine—cannot afford to

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conduct such long-term investigation as a chemical company which is free to turn from one raw material to another at will. My second guess is that some mining men have come close to exhausting their spirit of adventure in the search for minerals, and have little left over for an adventurous approach to utilisation of these same minerals.

Though in general the objectives in mineral exploitation by different countries will be similar, they may face vastly different problems. This is illustrated by reference to aluminium production where the industry seems to be anchored to a two-stage process of long standing. The first stage, production of pure alumina—whether for manufacture of the metal or for other important purposes—falls within the scope of to-morrow's Congress ; the second, electro-winning of the metal, does not strictly concern it. Yet unless one remembers that this second step consumes much electrical energy there is little incentive to start the search for a better overall process. The degree of incentive for any country to do this depends on the cost of its electrical power. Is it not time we gave up thinking of taking this same old process to the cheap power ? For some countries it will surely turn out better in the long run to devise an entirely new process.

One often senses a tendency for the investigator to stick too closely to the problem in hand, using only an extension of the methods that have been used before. Most metallurgists have no need to be reminded that their subject is based on chemistry and physics. Indeed, chemistry first came into existence from metallurgy and pharmacy and has been intimately associated with them ever since. Nevertheless, it is my opinion that many research metallurgists use new chemical and physical principles too sparingly. There is a difference between the traditional and the newer industries in this respect. The latter, owing their very existence to recent research, are the more enterprising in their use of it : they have to be. However, it is easy to over-emphasise the difference because over the centuries the traditional processes such as smelting and brickmaking have had the benefit of many an empirical experiment by the alert manufacturer—often based on a shrewd deduction or keen observation. In the aggregate this has amounted to a lot of research. My quarrel is therefore not so much with the efficiency of long-established processes as with the tendency to cling tenaciously to them. Inherently it looks unsound to roast sulphide minerals to the more stable oxides and then to prise the metal apart from the oxygen. Cannot a better method be found ? One hesitates to prophesy, but hydrometallurgy may provide an attractive alternative approach, or a reversion to chlorine metallurgy now that more resistant materials are available. The Broken Hill Associated Smelters in Port Pirie have been active in the investigation of newer methods of dealing with sulphide ores.

I have implied that metallurgy shades into chemistry and into physics. Indeed, any attempted distinctions between these disciplines are of the classroom for Nature certainly does not recognise them. The processor of minerals must be prepared to draw on a wide range of subjects—physics, chemistry, mathematics, statistics and, in recent years, even on microbiology.

We might pause here to consider what are the steps involved in exploiting minerals for mankind. First and foremost one must recognise a use for the mineral in question or for something that can be derived from it—such usage often being of very long standing. Many and varied are the uses to which minerals have been put and countless the companies mining minerals and converting them to useful purposes. Thus we have the glass and cement industries, the phosphate fertiliser industry, the building industry in so far as it uses bricks of clay, blocks of sandstone or marble, roofings of slate or walls of plaster. Whole sections of the chemical industry rely on minerals as raw materials ; from them come the mineral acids, an enormous range of phosphate compounds, inorganic insecticides, and more recently the fluo-hydrocarbons in which inorganic chemistry is married with organic chemistry.

Minerals abound, yet it would seem that opportunities to exploit them may for long remain unrecognised. During my lifetime several new materials based on minerals have come into use and, without wishing to detract from the credit due to the inventors, it has surprised many that their entry has been so long delayed. How simple in conception are the production of fibrous plaster sheets and of rockwool, yet how long did they take to reach the market ? Expanded aggregate and fibreglass also seem to be belated commodities. Bentonite has only assumed real importance during the present century. Thus one can safely predict that a host of uses for inorganic materials still await discovery. All of us must be sufficiently alert to recognise the importance of a chance observation : one experimenter at least could have found argon before Ramsay and Rayleigh had he but interpreted with the mind what he had seen clearly with his eyes.

To those of us with lesser discernment there are other approaches which can be equally rewarding. Thus one can select for study some one process used in the treatment of minerals in general, or some mineral in particular, and seek to improve it. Here again there are two methods of attack—the empirical and the fundamental, though sometimes they are best united. If one is pressed for time or beset with financial difficulties there may be no alternative to the empirical approach which, if one is sufficiently lucky, or discerning, may produce a big dividend quickly.

For those fortunate enough to have both time and adequate financial backing, the fundamental approach is the surer. It has the additional attraction that even if the practical problem proves to be insoluble, one will certainly add to the world's store of scientific knowledge. In the fundamental approach, as I see it, one must first identify all the relevant variables, determine quantitatively how each influences the process (and perhaps one another), and finally select the best combination for the particular purpose. In effect, one works on model systems and gradually builds up toward the complex systems of practice.

Another attractive procedure is to look into the mineral resources revealed by prospectors and geologists, and to seek new uses for some of the most abundant or promising deposits. This is a task for the courageous : there is no royal road to success. On the contrary, there is not even an orthodox method of coming to grips with the problem.

It is imperative that in exploiting minerals for mankind we do not exploit mankind for minerals. It is not my intention to dwell at length on the commercial aspects of mineral utilisation, but there are some matters which I hope you will agree are worth thinking about. Here the discussion automatically splits into the national and the international aspects. It will be expedient and less controversial in this audience if in discussing the national scene I confine my remarks to Australia. I cannot help raising controversial issues when I come to the international sphere. In this latter I realise, of course, that trading in minerals presents no vastly different problems from commerce in cotton or rubber—except that once removed minerals are not regenerated as is the case with agricultural crops. However, minerals occupy a very prominent position in exports in many countries, including Australia, where they are destined to play an even larger part in future. These countries are therefore much concerned about mineral exports, while the recipients are equally concerned about imports : an equitable deal is essential to both parties.

Within any given country the main factors which differentiate the mining industries from the manufacturing are isolation and, as a consequence, poorer educational facilities ; some health hazards; non-permanence of home and livelihood ; and possibly severe weather conditions. Often added to these in the bad old days was devastation of an originally pleasing countryside, with trees removed for firewood or killed by sulphurous fumes.

Not all of these disabilities can be removed, but most Australian mine managements are now doing just about as much as is possible to alleviate what remain. Broken Hill, which was fast becoming a treeless, dusty town, has been beautified and improved ; it is no longer a hardship to live there. Responsible prospecting companies think in terms of spending £2,000,000 or more when weighing the possibility of opening up new fields. This sum is required to provide plentiful water, a well-designed township with shopping and educational facilities, paved roads and first-class air transport. It is recognised that it is good policy to start correctly rather than to try to make amends later ; certainly the uranium mines at Rum Jungle and Mary Kathleen have had a magnificent start. The head of one mineral development company remarked to me recently—"We now house, educate, amuse and even air-condition our staff and labour forces." Unfortunately, a minority of those who deal in minerals are not sufficiently careful about health hazards. Often the offending companies are small and insufficiently aware of the dangers inherent in dealing with dusty minerals.

On the æsthetic side I would make a plea that in exploiting minerals there should be no desecration of the landscape. Those who have seen some of the coal and steel towns of Pennsylvania and in other countries will agree that this is a problem that is world-wide. On the other hand the Pennsylvania city of Pittsburgh has shown what can be done in the elimination of grime and ugliness. Formerly gold-dredges left picturesque parts of Australia as eyesores on the landscape : nowadays the dredged ground is restored to its former condition. Metallurgists and mineralogists take justifiable pride in the contributions that minerals have made from historic times to architecture and the arts. The Bible has many references to gems and ornamental stones and much early colonisation was due to the search for such materials. Marble was often exquisitely inlaid with malachite, jade, onyx, lapis lazuli or jasper or agate. The dome of many a church is of copper—St. Peter's in Rome and York Minster in this country are examples. Ghiberti's doors to the Baptistry in Florence are of bronze ; metal statues abound, and three-dimensional impressionism in metals is now a feature of art displays.

Australia owes much to its mineral industry. The goldmining rush of last century brought us an enterprising population. The Broken Hill lead-zinc mines made large profits out of which came the beginning of the steel industry and other industrial enterprises. So I suppose we should welcome overseas capital in opening up new mineral deposits. Not all Australians do, and in this they do not differ greatly from the citizens of other lightly-developed countries, for no country wishes to be too dependent on others for too long.

A land being newly opened up tends to follow established procedures. Consequently, an attempt is first made to find raw materials that fit into the straitjacket of overseas processes. Any departure from the normal is regarded as a drawback, whereas with sufficient research the abnormality might well turn out to be an asset. Cobalt in the Broken Hill ores nearly wrecked the electrolytic zinc process in Tasmania, but nowadays cobalt is a valuable by-product of the industry.

It is only natural that an overseas company will prefer to avoid the effort of modifying a standard process in order to cope with some local raw material ; it may be more profitable to look for standard material in another country. At any rate, I am not alone in concluding that if a country is to exploit its minerals satisfactorily it must establish facilities for research and development. This is why we in Australia have set up facilities like C.S.I.R.O. and A.M.D.L. for just this purpose. This is why our leading mining and metallurgical companies have their own research and development laboratories. Particularly in the developmental stage of a project my laboratory has found that the closest possible contact is needed with the company which contemplates operating the process. New York, London or Moscow cannot effectively do the development work for Chile, Malaya or Canada.

Automatic Control at Margam Marshalling Yard

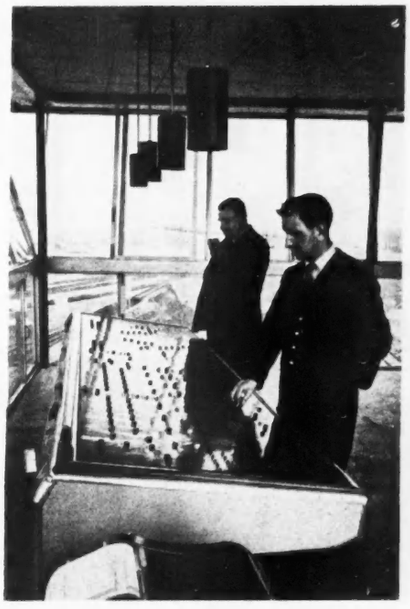
Computer techniques are used in this installation to derive voltages corresponding to the retarder pressures required for checking the speed of wagons running off the hump, and the release from the retarders is governed similarly as the sidings fill up, with provision for injecting certain modifying factors.

A NEW railway marshalling yard covering 170 acres of what was formerly a tract of sand dunes at Margam (Glamorganshire) was officially opened on April 11 by Mr. K. W. C. Grand, member of the British Transport Commission. The yard, one of the major works in the modernisation programme of the Western Region, British Railways, is on the east side of Port Talbot and was designed in close co-operation with the Steel Company of Wales, to whom fifteen sidings have been allocated. In all there are twelve reception sidings, fifty double-ended sorting sidings, ten single-ended holding sidings, and seven single-ended transhipand cripple sidings. The extent of the sorting sidings is seen in the accompanying night view from near the hump summit, with the control tower visible on the left.

Margam yard is stated to be more fully automatic in operation than any similar installation in Europe. Computer control is applied both to primary and secondary retarders. The system provides a voltage analogue of required exit speed from the secondary retarders, and compares this with a voltage analogue of actual speed, the error voltage then controlling the retarder pressure.

Sorting sidings at Margam seen from near the hump summit

The main contractor for the signalling and control equipment and retarders was A.E.I.-G.R.S., Ltd. (formerly Metropolitan-Vickers-G.R.S., Ltd.). Improved procedures introduced in this installation begin with the punched tape programming for operating the sorting siding points. The tape is produced in the traffic office at the control tower on a reperforating teleprinter, from information transmitted by portable radio-telephone by the shunter who divides arriving trains into cuts according to the wagon destinations. When a train is about to be humped, the corresponding tape is fed into a tape reader. Operation of a push-button on the control room panel (seen in the second illustration) starts the tape, which initiates control signals for setting the points as



Signalling and humping control panel in control tower operating room

necessary to direct the cuts into the appropriate sidings. The control signals, in the form of destination codes, pass in succession through an indication store, where four destinations at a time are displayed to the operator, and then through a series of relay stores, one for each track circuit. They are not accepted by a store associated with an occupied track circuit so that there is no interference with the control of the points for a preceding cut.

The driver of the locomotive propelling the train over the hump has a continuous indication in his cab of the humping instructions (" hump normal," " hump slow," or " stop "). This is a light signal with horizontal and inclined rows of lamps, and is operated by an alternating current in the rails with alternative frequencies of the order of several hundred cycles. One or other frequencies, according to the indication required, is superimposed on the normal d.c. track circuit and is picked up inductively. Absence of code is arranged to signal " stop." Any change of aspect is accompanied by an audible warning.

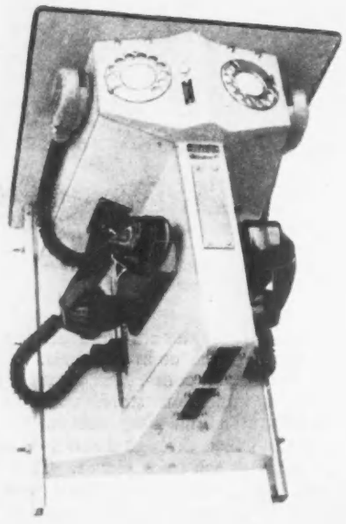
The automatic control of the electro-pneumatic retarders takes account of standage space in the sidings as well as weight, speed and " rollability " of wagons, and provision is made for manual biasing of wagon release speeds from the retarders to allow for the effects of strong adverse or following winds,

and for the slightly higher pressures required when rails are wet.

Measurement of "rollability" is effected by two pairs of inductive wheel detectors operating at supersonic frequency, preceding each retarder. The signal from each pair is used to operate a high-speed binary counter giving a count inversely proportional to the speed of the cut. As the distance between the pairs of detectors and the gradient are known, the count is computed electronically to produce a voltage representing the rolling resistance of the cut. This voltage is transformed into a digital code and passed forward to the release speed computer.

Other inputs to the release speed computer are derived from voltages proportional to distance-to-run and curvature, the latter being constant for each siding and selected automatically when the route is set up. Distance-to-run is taken from a standage store for each siding, consisting of a potentiometer controlled by the state of the siding track circuits. As wagons enter the siding, the potentiometer is stepped by an amount corresponding to the length of each cut. The output voltage is thus reduced as the siding fills up.

Actual speed of wagons approaching retarders is measured by v.h.f. equipment utilising the Doppler frequency-shift effect, and a proportional voltage is produced. This measured-speed voltage and the required exit-speed voltage, together with information from a weight detector preceding each primary retarder, are then fed to the pressure computer, which produces a voltage output defining the pressure required in the retarder cylinders to remove the excess energy from the cut. At the retarder this voltage is compared with that from a pressure transducer mounted on the air manifold, providing the means to operate the inlet and exhaust air valves so as to maintain the pressure in the cylinders equal to that demanded.



Pull-out drawer of control panel, housing telephone and microphone equipment

Primary retarders are controlled similarly to the secondaries except that distance-to-run is not involved at this stage. The weight-detecting device preceding these retarders consists of a group of micro-switches which are mounted in a short length of slotted rail.

The control panel in the control tower is in two portions, that on the right operating the signalling of the reception sidings and associated tracks on the entry-exit route-setting system, while the left-hand portion controls all equipment associated with humping operations. Each retarder has two switches. One switch has an automatic position and three manual positions for selecting retarder pressures by hand if necessary; the other has a "computer" position for fully automatic control of release speeds, as described earlier, and five manual positions, enabling preset speeds to be selected. Provision is also made for manual operation of points as an alternative to the normal route-storage system.

The panel is a "Domino" panel constructed on the "Integra" system, for which the British licensee and manufacturer is Henry Williams, Ltd., Tolpits Lane, Watford. It is built up of units 40mm square arranged to form a combined track diagram and operating panel with push-button or rotary switches and repeater lamps. Certain units are "blanks," containing no operating elements but being engraved with a portion of the track diagram so that continuity of presentation is preserved where no controls or indications are required. Units and "blanks" are supported in a grid. Each unit comprises a lower insulated portion with the contact pins and connections, an upper moulded part carrying the optical parts and push-buttons, and a cover plate forming part of the panel diagram. Twelve contact points are provided in each unit, enabling up to twelve lamps or six single-contact push-buttons to be accommodated, or various combinations of these accessories. All lamp bulbs are of clear glass, the required colours for different indications being provided in the inorganic glass optics of the "Domino" unit. These principles are embodied in the Margam control desk, which also has certain special features, including the pull-out drawers (one of which is illustrated) containing dial telephones and microphones for v.h.f. radio or loudspeaker communication with shunting locomotives and various parts of the yard. The radio equipment was supplied by Pye Telecommunications, Ltd., and the sixty-line automatic telephone exchange, which also gives access to the main railway trunk network, by the Reliance Telephone Company, Ltd.

Main lighting in the yard is provided by 216 Benjamin "Duoflux" floodlights with 1000W filament lamps, mounted 55ft above ground level on tubular steel towers with triangular bases having 2ft 6in sides, on square bases with 1ft 6in sides, according to the space available between tracks. Light distribution from the "Duoflux" fittings is controlled so that the main illumination is directed towards movement along the yard while shunting and glare is avoided. The lighting is controlled from two mimic diagram consoles supplied by The General Electric Company, Ltd.

The whole scheme has been developed and directed by Mr. M. G. R. Smith, M.I.C.E., Chief Civil Engineer, and Mr. A. A. A. Cardani, A.M.I.E.E., M.I.R.S.E., Signal Engineer, Western Region.

In addition to those named in the text, the following contractors were responsible for work as shown.

PRINCIPAL CONTRACTORS

Main contractor (earthworks, permanent way, bridgework, drainage, fencing, amenity blocks), Sir Robert MacAlpine (South Wales), Ltd.; control tower, John Morgan, Ltd.; earthworks and permanent way, Robert M. Douglas, Ltd.; main electrical contractor, British Insulated Callender's Cables, Ltd.; signalling cables, British Insulated Callender's Construction Company, Ltd.; internal electrical installation in control tower and yard buildings, Lee Beesley and Co., Ltd.

Birmingham Firm's Bicentenary

Two centuries of manufacturing activity have been completed by Geo. Salter and Co., Ltd., West Bromwich. The early history of the firm is fragmentary, but it is quite certain that by the middle of 1760, Richard Salter was in business as a "spring maker" at a small bay-windowed house in Bilston, where he lived and worked. Three of Richard's brothers are mentioned in contemporary records, one of them, William Salter, being described as a "pocket steelyard maker." Some time between ten and twenty years later, that is somewhere from 1770 to 1780, Richard Salter moved to West Bromwich and continued there the manufacture of springs and spring balances which is to this day the major part of the firm's business. Moreover, Richard developed other products which incorporated the use of his springs, a vertical roasting jack being one of them. In addition, he included the manufacture of bayonets, for which there was a growing demand at the time, in his list of products. William Salter's two sons, John and George, subsequently followed their uncle Richard to West Bromwich and they were described as bayonet makers.

That, briefly, was how the firm started. In the early 1800s, the family tree becomes a little confused by duplicating the use of Christian names! The George Salter from whom the present company takes its name was the George mentioned above. He exercised considerable influence in the then growing town of West Bromwich as well as over the growth of the business. Among the patents granted to him was one, dated 1838, for a "spring balance or spring weighing apparatus, with a method of indicating the weights by means of an index and scale of divisions marked on the exterior of a tube either curved or plane sided." Then, in 1850, there is reference to the firm making "a portable and convenient domestic weighing apparatus, also an indicator of the pressure of steam when adapted to locomotives and other engines." In the succeeding years the Salter family married into the Bache family. The last George Salter died in 1915, since when members of the Bache family have been responsible for the management of the company. Mr. F. E. L. Bache is now the chairman and Mr. R. P. S. Bache, managing director.

In its first 200 years, George Salter and Co., Ltd., has extended far beyond the small house in Bilston where Richard Salter coiled springs in the back kitchen and the backyard. An excellent bicentenary volume entitled *The Story of a Family Firm*, which has been written by Mary Bache, contains some of the recollections of one of the firm's outstanding employees, John Hughes, who started in 1845 at the age of nine and continued to work until he was ninety-one, in 1927. When Hughes joined the firm, there were between seventy and eighty employees, making spring balances, steelyards, bottle jacks and bayonets, the work being done by foot-operated lathes and hand presses; the only lighting was by candles which were known as "short eights." Now, in addition to the main factory at West Bromwich, there is a factory at Smethwick, most of which is devoted to the manufacture of heavy springs. The bicentenary volume contains many interesting details of the variety of springs, balances and other Salter products.

Last week we had the pleasure of visiting the company's works to see the existing methods of spring manufacture and the making of retaining rings and fasteners which is a development of recent years. We saw also the careful testing which is given to the many kinds of weighing machine produced at West Bromwich. Furthermore, at the Smethwick factory, there has been developed a system, known as "Salterpak," for the prepackaging of various goods.

During our visit, in company with other representatives of the press, we were guests at a 1760 dinner given by Geo. Salter and Co., Ltd., at the New Inns, Handsworth, "a fine coaching house lately built by the High Road for the better accommodation of Travellers to the Welsh Coast for the Irish Packet." It was a memorable occasion, the more so as the guests were conveyed from their hotels in Birmingham by six stage-coaches.

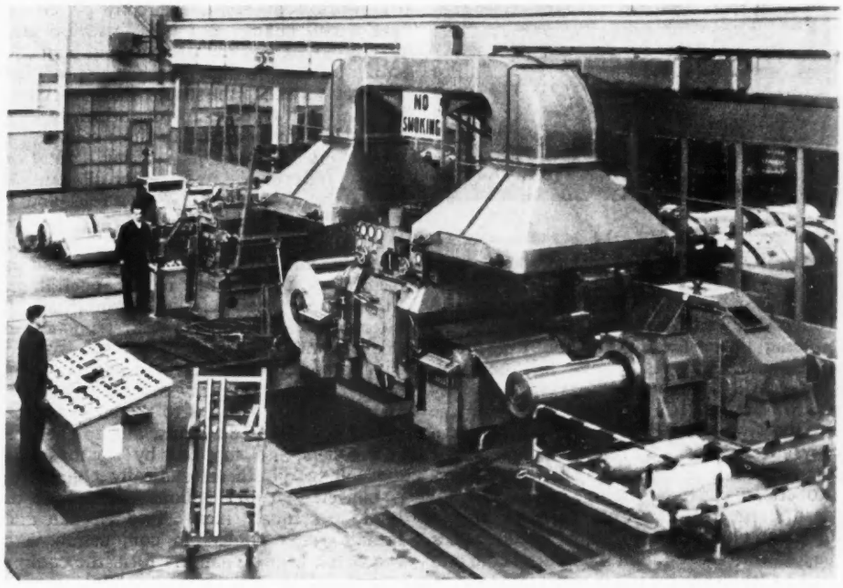
Aluminium Strip Mill at Woodgate Works

The expanding demand for aluminium alloy sheet decided Birmetals, Ltd., to increase the capacity of its plant and for this purpose a Sendzimir cold strip mill, together with ancillary equipment, has been installed in a new building. The 50in reversing mill can roll from 0·1875in down to 0·006in, taking a coil up to 10,000 lb in weight, and will roll between 12,000 and 20,000 tons of aluminium alloy sheet per annum.

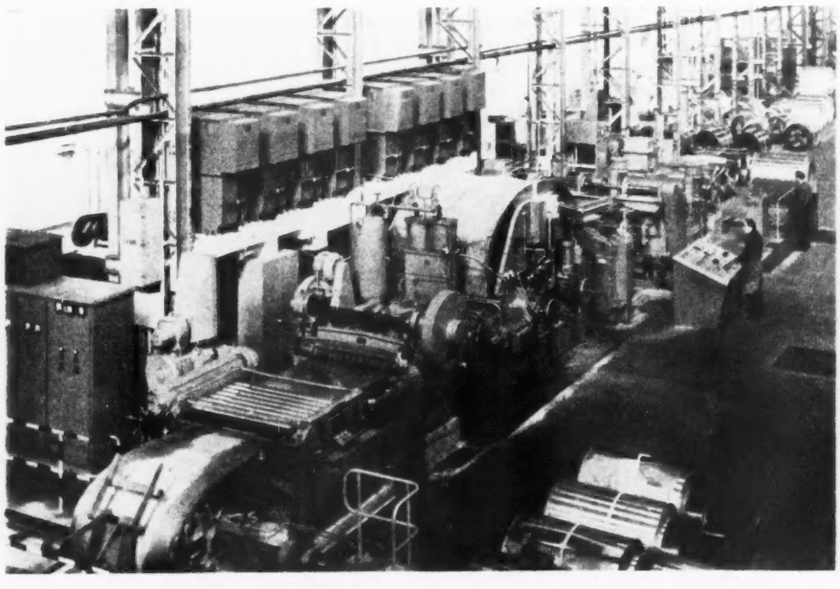
THE trend of post-war demands for aluminium alloy sheet and an estimate of market developments in the future determined Birmetals, Ltd., to embark on a programme of expansion so that production would be equal to market requirements. This decision was taken in 1956 and since then work has gone forward on a project which has as its principal unit a Sendzimir high precision cold strip rolling mill which, although it had been used with stainless steel, had not been employed for the rolling of work-hardening high-strength aluminium alloys. This 50in reversing mill rolls 0·1875in thick material down to 0·006in, requiring five passes to reduce down to 0·045in and three or four more to produce sheet 0·006in thick. For economic reasons it was essential for the coil stock to be as long as possible and at present provision has been made to produce a coil weighing approximately 8000 lb for rolling in the mill. To produce such a coil by direct rolling would have involved the installation of a hot mill capable of handling an 8000 lb slab, at great cost, and also resulting in making certain existing plant redundant. The solution of the problem lay in the adoption of the idea of welding together a number of smaller coils to give the desired weight. A scheme was formulated and eventually a machine built capable of flash butt welding strip up to 52in wide.

The mill, coil annealing furnace, sheet annealing furnace and ancillary equipment, have now been installed in a new building and, on Thursday, April 7, the Marquess of Exeter, the chairman of Birmid Industries, Ltd., formally set the mill in motion at the Woodgate works of the company.

Billets up to 22ft 6in in length and 8 tons in weight are produced by existing equipment by the continuous casting process and cut to size required by the mill. After testing by ultrasonic crack detectors, the billets pass through preheat furnaces before transfer to the main breaking-down mill. From the run-out table the strip which has been rolled to a thickness of $\frac{5}{16}$in passes through an edge trimmer and an up-coiler and after being annealed passes to a four-high strip mill, where it is further reduced in thickness and coiled. These coils, weighing about 2 tons, are now forwarded to the welding line which has been installed in the same building and consists of a pay-off stand, supplied by the Bronx Engineering Company, Ltd. ; a feeder leveller ; end shears ; the main butt welding unit ; weld flash dresser, provided by Wadkin, Ltd. ; edge trimmer and scrap chopping units, supplied by Auxiliary Rolling Machinery, Ltd., and finally pinch rolls and tension reel manufactured by The Wellman Smith Owen Engineering Corporation, Ltd. The welding line is shown in our illustration. A.I. Electric Welding Machines, Ltd., was responsible for the manufacture of the flash butt welder which had to incorporate a special technique so that the electrical loading condition would not cause excessive disturbances in the supply network. As originally envisaged, the loading when flashing took place was 1330A at 400V and 10,000A when the weld was forged, while, as finally designed, the electrical load in flashing is 725A (290kVA) and at the instant of forging 5800A (2320kVA).



Sendzimir 50in reversing strip mill

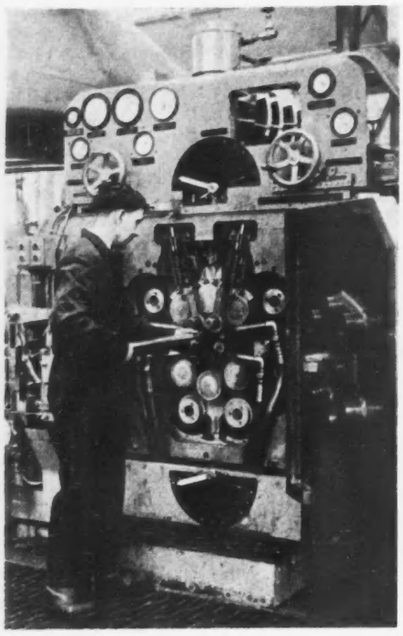


Welding line, with the flash butt welder to the left of the control panel

At the welding line the first coil is passed into the line, the leading end is sheared and strip passed through to the edge trimmer, pinch rolls and tension reel and the rear end sheared. It should be noted that the end is sheared about 3 deg. off square. Meanwhile, No. 2 coil has been introduced into the line and the leading end sheared and moved to the welding machine. The tail end of No. 1 coil and the leading end of No. 2 coil are held in clamps, leaving a gap as set by a gauge. The welding cycle is started : the metal is induction heated and later the ends of the strips are brought into contact, flash welded and forged. The process is repeated to join No. 3 coil to No. 2 and No. 4 coil to No. 3. As the welded strip moves forward, the weld flash is removed in the weld dresser before the strip is edge trimmed and finally coiled in a Wellman expanding mandrel tension reel and drag generator pinch roll unit to produce a coil approximately 50in to 53in in diameter and weighing up to 8500 lb.

Sendzimir Mill and Equipment

All the mill equipment, except the welding line, is housed in a new portal frame building



Arrangement of rolls in Sendzimir mill showing the changing of a work roll

covering an area of 45,000 square feet and conveniently sited to take the coils from the welding line. Braithwaite and Co. Structural, Ltd., was responsible for the steelwork, the civil engineering was carried out by R. M. Douglas (Contractors), Ltd., and the architect was Mr. F. J. Meeson. The main bays are 200ft long by 78ft wide; one houses the Sendzimir mill and the other a Hallden-Robertson cut-to-length line and a G.W.B. flash annealing furnace. There is also a despatch bay measuring 120ft by 60ft, and a bay 45ft wide to contain the motor room and coil annealing furnace. Some 2500 tons of concrete and reinforcements were used for the foundations and the ground excavated to take clean and dirty rolling oil tanks, having a total capacity of 16,000 gallons, and ancillary equipment. The firm's own products have been used in the construction of the building which is clad with trough section "Birmabright" aluminium alloy sheet down to the perimeter wall. All roofing and side sheeting is lined with wallboard and insulated with fibreglass and it is expected that the cost of the lining will be recovered over three heating seasons. Ventilation is by Colt ventilators.

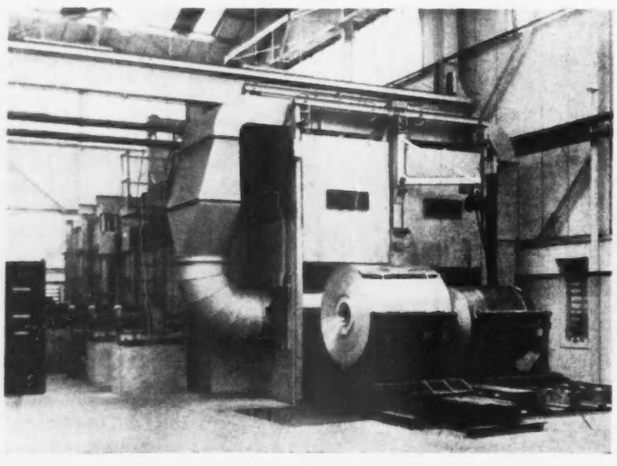
Built by W. H. A. Robertson and Co., Ltd., and illustrated herewith, the mill, which has a capacity of between 12,000 and 20,000 tons per annum, is a 50in reversing unit having a maximum speed of 1600ft per minute, a thickness range from 0·1875in to 0·006in, and a finished coil width of 48in. Thickness of the strip is indicated to the mill operator by a Baldwin nucleonic thickness gauge which has been tailor-made and uses Strontium 90 as a source, and measures the thickness over a range of 0·120in to 0·003in without contact with the metal. Of cluster pattern, the mill has 2⅝in diameter work rolls which are ground to such precision that the strip has sensible uniformity across its width. For roll grinding purposes a Naxos-Union machine has been installed. The work rolls are not directly driven so that a roll change can be effected in less than a minute and the last pass can be made with rolls having a high finish which produces a mirror surface to the strip. Each work roll is driven by two back-up rolls which in turn are backed up by an arc of three rolls and a further arc of four rolls, making a total of twenty rolls in the mill. Our illustration shows the arrangement of the rolls and a work roll being changed.

Each coil is fed through flattening rolls into the mill from a pay-off reel, and is recoiled ready for the rolling operations. The strip is passed through the mill in both directions with an approximate reduction in thickness of 10 per cent at each pass so that eight or nine passes serve to produce strip of the minimum thickness. The hydraulic and lubrication supplies to the entry section of pay-off and feeder units, and to the mill and coilers, are supplied by pumps and the rolling oil, thermostatically controlled, is delivered at 677 gallons per minute at 150 lb per square inch. Two Heenan and Froude water coolers in conjunction with two Serck heat exchangers form the cooling system, while a by-pass filtration system ensures a supply of clean oil. Flameproof immersion heaters are fitted in both clean and dirty oil tanks. Plant for the ventilation of the oil basement and for the extraction of fumes from the mill was provided by The Industrial Fan and Heater Company, Ltd., "Airflo" p.v.c. hood and ducting being fitted on the mill.

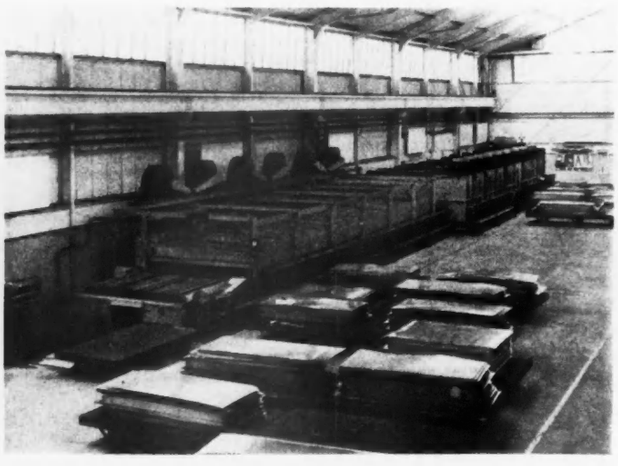
All the electrical motors, switchboards and control panels are housed in a pressurised room which has a glazed partition between it and the mill bay. Four d.c. generators, two rated at 750kW and two at 870kW 600V, driven by a 3500 h.p., 1000 r.p.m. synchronous motor, provide the power for the mill and coilers respectively. The mill is driven through David Brown gearing by two 900 h.p. 500/1000 r.p.m. motors in tandem and each winder is driven through gearing of the same make by three 350 h.p., 200V, 500/1250 r.p.m. motors in tandem. The latter provide a maximum tension of 25,000 lb, and by means of an electrically-operated disengaging coupling the inboard motor may be used by itself to give a lower tension of 8000 lb when lighter gauge material is being rolled. The wheel drives and the mill drive and part of the generator set are illustrated opposite. All the equipment was manufactured by Associated Electrical Industries, Ltd. Air supplies are drawn in through Visco box pattern air filters having a capacity of 65,000/70,000 cubic feet per minute by four 25 h.p. axial flow fans and discharged into a tunnel below the motor room. This cooling air is supplied to motors and generators, and the resultant build up of air pressure in the motor room is controlled by electrically-operated roof ventilators.

Intermediate annealing of the strip is carried out as required, and for that purpose a coil annealing furnace, manufactured by Stordy Engineering, Ltd., and seen in our illustration, has been installed. This pusher furnace, rated at 550kW, and having five compartments, each with a fan to circulate the hot air, will hold twelve 8000 lb coils, and has a capacity of 8000 lb per hour. The coils have a residence time of twelve hours and the doors between the compartments open simultaneously when the coils are moved from one zone to the next. The ingoing coils advance progressively through the preheating zones to the high temperature zone, which they leave at a temperature of 450 deg. Cent., and return via the successive preheating zones. Each of these chambers is also occupied by an ingoing coil and the heat transfer which takes place effects economies in heat requirements such that the electrical loading is half that required for batch annealing.

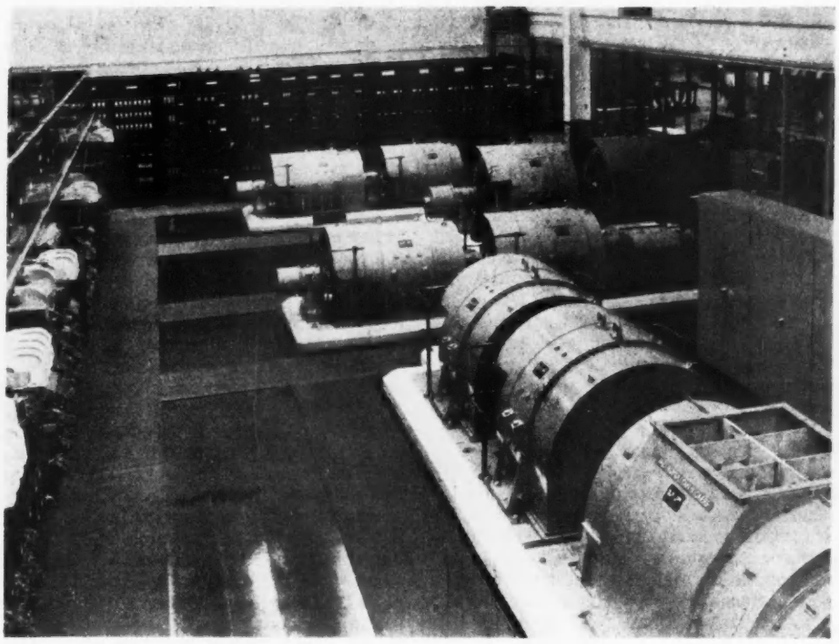
The finished coils pass to the slitting and cut-to-length lines. Auxiliary Rolling Machinery, Ltd., supplied the slitting line, which will supply 52in diameter coils slit to any width down to 1in, and has a maximum line speed of 800ft per minute and a thickness range of 0·080in to 0·005in. In the Hallden-Robertson cut-up line the maximum strip speed is 350ft per minute, the thickness range is from 0·080in to 0·010in



Coil annealing furnace



Flash sheet annealing furnace



General view of the motor room showing reel drives and mill drive and part of main motor generator set

while any length from 24in to 192in can be cut. After being cut to length the sheets are passed through a G.W.B. flash annealing furnace, which we illustrate, and which consists of a 40ft long annealing furnace, having four heating zones and a rating of 600kW, followed by a 42ft long cooling chamber. Sheets up to 8ft wide can be accommodated, and are carried on continuous nickel alloy tapes at speeds ranging up to a maximum of 100ft per minute.

A 10-ton hand crane serves the motor room, and a 7½-ton serves the mill bay, both provided by The Vaughan Crane Company, Ltd. In the finishing bay is a 7½-ton crane, while in the despatch bay is a 3-ton crane, both supplied by the Wharton Crane and Hoist Company, Ltd.

Symposium on Ship Trials

A SYMPOSIUM on Ship Trials and Service Performance Analysis was held on April 11, 12 and 13 by the North East Coast Institution of Engineers and Shipbuilders. The programme consisted of the presentation of eight papers, four being read on Monday, April 11, and four on Tuesday, while on Wednesday visits were arranged to the Department of Naval Architecture and Shipbuilding, King's College, and to shipyards and engine works. At the four sessions held on Monday and Tuesday the following papers, of which we include synopses, were presented.

THE PREDICTION OF SHIP PERFORMANCE FROM MODEL TESTS: THE NATURE OF THE PROBLEM

By Sir Victor G. Shepheard, K.C.B.

The paper discusses in general terms the various factors involved in the prediction of ship performance from model tests, with particular reference to matters not yet fully understood and upon which further work is required. These are considered in relation to the model tests themselves, the extrapolation of the model results to the full scale, and the correlation of ship predictions with performance on measured-mile trials. Finally, the correlation of trial results with service performance is discussed and reference made to research into the seagoing qualities of ships.

It is apparent that there are many matters to be resolved and clarified before it can be said that the correlation of ship and model results is entirely satisfactory, and reference is made in the paper to steps being taken by B.S.R.A., largely in conjunction with Ship Division, N.P.L., to improve the position.

METHODS FOR CARRYING OUT SHIP MODEL RESISTANCE AND PROPULSION EXPERIMENTS

By Dr. F. H. Todd, B.Sc., Ph.D.

The method by which model experiments are carried out can have some effect upon the power prediction made for the ship, and it is, therefore, very desirable that an agreed procedure should be followed in all towing tanks.

This paper outlines the two basic methods at present in use, referred to generally as the British and Continental methods, and then gives a general account of the recent standard procedure agreed to by the British tanks. This procedure is being submitted to the International Towing Tank Conference for discussion, and it is hoped that it will form the basis of an international agreement.

PROPELLERS IN ACTION BEHIND A SHIP: TRIAL TRIP AND VOYAGE ANALYSIS

By Professor L. C. Burrill, M.Sc., Ph.D.

The paper discusses the basic conditions of design for marine propellers, and states that it is usual to design for average fair-weather conditions at sea rather than for a trial-trip condition. Methods of analysis are described whereby an analysis wake fraction, q.p.c., hull-efficiency factor and thrust-deduction factor may be deduced from full-scale ship data. Using a four-weather intensity scale, an example is given showing the effects of displacement, weather and days out of dry dock on the performance of two cargo liners with inward- and outward-turning screws. Finally, analysis results are tabulated for fourteen recent ships of different types showing comparisons with the original design figures and with the tank-test results.

A METHOD OF PREDICTING MEASURED-MILE PERFORMANCE FROM TANK AND TRIAL RESULTS

By D. I. Moor, B.Sc.

The paper describes a method of predicting the measured-mile trial performance of a ship from tank experiments on the form, with corrections derived from past trial results with similar ships. The full process is divided into three self-contained stages:

(1) Analysis of model results; (2) Prediction of ship performance; (3) Analysis of ship results.

In stages (1) and (3), the characteristics are obtained of standard chart propellers which have the same thrust horsepower : speed : revolutions-per-minute relations as the model and ship propellers, and scale effect factors are computed for revolutions-per-minute, and effective horsepower. It is suggested that, for predicting purposes only, these factors may satisfactorily be taken as functions simply of ship length. In stage (2), the dimensions of the chart propeller equivalent to the actual ship propeller are calculated. The performance of this chart propeller is predicted from the chart, and then corrected to apply to the ship.

SERVICE PERFORMANCE OF A FLEET OF TANKERS

By A. Logan

On a basis of all-in fuel consumption the paper briefly reviews the service speed results achieved by certain classes of ships in the fleet of tankers with which the author is associated. A series of graphs is presented showing the main trends of speed fall-off over the years, together with the relevant tank and acceptance trial data and the principal details of the vessels under consideration. The limitations of the method adopted to present the service speed graphs are discussed, and it is explained that no other system of presentation was possible with the data available. It is stressed that the instruments and techniques currently in use for the purposes of measuring speed through the water, shaft horsepower and fuel rates are not sufficiently accurate or reliable to enable adequate checks to be made on the performance of ships in service. Observations on the progress of various aspects of ship research are accompanied by comments on the service experience gained in the fleet of tankers under review. The author mentions the many variables affecting the service performance of tankers and comments on the difficulties involved in assessing the various factors that contribute to the overall loss of efficiency.

TURNING AND MANŒUVRING TRIALS

By R. N. Newton, R.C.N.C.

This paper outlines and distinguishes between the qualities which together constitute the manœuvrability of a ship, but which are to some extent conflicting. The technique employed by the Admiralty Experiment Works for conducting turning trials to determine the geometry of the turning path of a ship at different speeds of approach and rudder angle is described in some detail. A brief description is given of the principles of spiral and zig-zag manœuvres, by which the course-keeping qualities can be assessed, together with a note on the order of accuracy of ship-model correlation to be expected.

PERFORMANCE IN SERVICE OF CARGO VESSEL AND PASSENGER SHIPS

By J. Dieudonne and M. Jourdain

This paper describes the graphical methods used by the Institut de Recherches de la Construction Navale to separate the various influences (i.e. displacement, trim, fouling and weather), which affect the propulsive performance of ships in service. It includes in summary form a number of results: in certain cases these are very clear, but in others the investigation shows that the results are not capable of satisfactory analysis.

The authors consider that, if the records are good, the method of analysis is of little importance, while if they are mediocre the procedure described will make this evident, and will thus prohibit any kind of conclusion, while more automatic methods would have given definite figures, but without true significance.

THE RECONCILIATION OF MODEL DATA, MEASURED-MILE RESULTS AND SERVICE PERFORMANCE OF SHIPS

By Professor E. V. Telfer, D.Sc., Ph.D.

After a consideration of the present position of the turbulence stimulation, wall-effect and tank tidal drift problems, attention is directed to frictional formulation issues. A revised extrapolation formulation enables Hughes's N.P.L. experiment data to be better interpreted and used for equivalent plank or ship-model plus form-effect extrapolation.

The problem of the rough ship or model is next considered. By joint rough and smooth model testing a new method of extrapolator slope determination is evolved. For the rough ship a simple method of dealing with plate surface quality independent of ship size is given, thus facilitating statistical analysis.

Model propulsion conditions are next examined from the standpoint of the influence of propulsive coefficient and thrust-deduction scale-effects on ship frictional resistance determination. The use of air-jet partial propulsion to determine thrust-deduction is recommended. Propeller revolutions and wake scale effects are also considered.

The problems of ship trial analysis are reviewed and the construction of combined generalised power and thrust diagrams recommended for the more accurate statistical analysis of trial data. The use and simple modification of such diagrams to allow for changing hull roughness is developed. Their application to ship service analysis to determine non-dimensional power-loss factors jointly influenced by weather and fouling concludes the paper. An appendix enlarges on weather analysis.

LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LONG WELDED RAILS

SIR,—It is with extreme reluctance that we join in a correspondence which seems likely to become very unprofitable, but Mr. Turner's latest letter on the subject of rails contains a statement which we cannot but refute. We refer to Mr. Turner's claim that he had sent copies of his initial article to some senior members of the Research Department of British Railways, and who, by their subsequent silence, implied that they agreed with the statements made therein.

As two of the recipients of these communications we wish to protest strongly against the assumption that we agree with the substance or indeed any part of Mr. Turner's article of March 4. In actual fact we fully support the views expressed by Mr. Bartlett in your issue of April 1.

I. G. T. DUNCAN, B.Sc., A.M.I.Mech.E.
S. WISE, M.I.Mech.E., A.I.M.

Derby,
April 12, 1960.

Book Reviews

Automatic Refrigeration. By S. A. ANDERSEN. MacLaren and Sons, Ltd., 131, Great Suffolk Street, London, S.E.1. Price 85s.

IN writing this book, the author makes a useful contribution to the refrigeration engineers' library. The main part of the work is devoted to the automatic control of refrigeration installations and to the various devices which have been developed for this purpose. There have been a number of works published recently dealing with the fundamentals and general application of automatic controls, but this is the first book which deals with the particular problems of the refrigeration engineer. This book is sponsored by and published for a well-known Danish manufacturer of refrigeration controls ; it is therefore not surprising that many of the excellent illustrations show controls from this manufacturer's considerable range. This fact does not detract from the value of this work, as the controls illustrated are typical and serve to illustrate the construction and principles of operation, which are explained in some detail ; it does, however, slightly limit the scope in some respects.

The book may be divided roughly into three parts : the first part deals with the aims and principles of refrigeration, particular attention being paid to the control of humidity. An introduction is also given to the fundamentals of automatic control. In the second part, specific controls for temperature, pressure, flow, &c., are described in detail and many illustrated examples are given of a wide range of automatic refrigerating plants.

The third section has nothing to do with automatic control, and could well form a separate volume, entitled " What the Refrigeration Designer Wants to Know." In compling this third section, the author and his associates have performed a valuable service to the designer by collecting together a wide range of basic information and formulæ and giving examples of their use. The range covered includes the calculation of refrigeration loads, heat transfer coefficients and compressor performance. Finally, some 130 pages are filled with tables of physical and design data, concluding with refrigerant tables in both British and Metric units. Sets of refrigerant pressure-enthalpy diagrams, again in British and Metric units, are supplied in a pocket separate from the main book.

Throughout the work the author continually makes reference to his sources of information, which are listed, together with other related literature, in an appendix. This is of considerable assistance to the reader who requires more detailed information on the subjects discussed. A useful inclusion in the section on automatic controls would have been a chapter on correct and incorrect applications. A further minor criticism of this work is that a few of the technical terms used are a little unorthodox, as is the spelling in some places. This book will be useful both to the student who is studying refrigeration and to the practising engineer, to whom the collection of data will be of considerable value.

Maschinenfundamente und andere dynamisch beanspruchte Baukonstruktionen. By E. RAUSCH. Third revised and enlarged edition. Düsseldorf : V.D.I.-Verlag G.m.b.H., Düsseldorf, Bongardstrasse 3. Price DM.126 (10 per cent rebate for V.D.I. members).

THE design of machine foundations is a task to which all too frequently insufficient attention is paid, with the result that costly failures occur which entail dismantling of the machinery and lengthy repairs to, and even rebuilding of, the foundation structures. The main reason for this state of neglect appears to be the inclination, on the part of mechanical engineers, to refer a basically dynamical problem to designers who are familiar with structures chiefly from the point of view of statics. Professor Rausch's compendium will, therefore, be widely appreciated by all concerned, giving as it does, an up-to-date picture of the whole range of foundation structures, and being written with the needs of the practical designer in mind throughout. In the first four chapters are discussed the general aspects involved and the dynamical theory, as well as questions of material fatigue. The determination of the stiffness and natural frequency of vibration receives attention in Chapter 5, which is followed by two chapters dealing respectively with the design and construction of foundations for machinery giving rise to single or irregularly repeated shocks, and machines causing linear or rotary periodic vibrations. Throughout, the reader is referred to actual design problems, the data for which, and numerical calculations, are quoted in detail. This fact, and the inclusion of a large number of dimensioned sketches, keep the discussion firmly on a concrete basis, and impart an invaluable ability to visualise the practical difficulties and problems presented by each case. As an example, we may quote the design of a test pit for extra-heavy rotors to which eighteen pages are devoted. Here, the problem was to replace, by an adequately strong structure, a pit destroyed by a rotor which burst under test, and the author takes us step by step through the various theoretical and practical calculations involved.

Problems of particular interest are foundations for high-speed rotating machinery, such as turbines, and special chapters are devoted to the construction of steel and reinforced concrete foundations for these purposes. Other questions include the placing of machinery, mainly machine tools, on existing floors in buildings, and the construction of foundations in situations when mining subsidence must be expected. Miscellaneous problems concern the damages sustained by foundations and building through shocks and vibrations ; the effect on people of vibrations and noise ; and the elimination of vibrations by means of connected tuned systems of elastically supported, subsidiary masses. The final chapter is devoted to various problems of a dynamical nature arising in civil engineering, such as vibrations of buildings, chimney stacks, hydraulic structures and instrument foundations, and the load capacity of piles. A full index of literature lists books, articles, and industrial standards up to the end of 1958 ; reference to the literature is facilitated by an index arranged according to the names of authors, as well as a subject index.

Operator Training in Industry. By W. DOUGLAS SEYMOUR. Institute of Personnel Management, 80, Fetter Lane, London, E.C.4. Price 7s. 6d.

THIS addition to the booklets of the Institute of Personnel Management is concerned primarily with the training of unskilled and semi-skilled operators in the manufacturing industries. It gives an outline of some recent techniques developed for correct operator training based upon experience in factories and investigations carried out by a number of universities and research institutes. Sections of the booklet are devoted to training of new workers in handwork, handwork with tools, single- and multi-purpose machine work, group machine work and non-repetitive work. Some interesting graphs are given which compare the progress of trainees who have undergone specialised training and those who have learnt their work in actual production. These graphs show unmistakably the value of studied and systematic training and the fact that such trainees attain a higher level of production in a much shorter time than those who just " picked the job up " on the factory floor.

Petroleum Refinery Manual. By H. M. NOEL. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 64s.

THIS manual presents an integrated description of refinery design and construction which includes details of standard techniques of petroleum processing and associated economics, and is illustrated with flow diagrams of many of the processes involved. There are five chapters of which the first is entitled "Preliminary Considerations," and the second is concerned with engineering, dealing with planning and estimating. Details of the building time of typical units are given together with samples of various estimates, followed by design flow diagrams, heat balance tables and power requirements.

After a short chapter on shop fabrication touching upon methods, there is a section concerned with various aspects and problems of field construction starting with site clearance. This chapter records construction time and the manpower required for a range of plant, with a break down into the various constructional items and trades involved. "Operations and Equipment" is the title of the fifth chapter which gives details of organisation, manpower for refinery operation, together with flow diagrams and data concerning various refinery units and processes.

Naval Architecture. By B. Baxter, M.Sc. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 10s. 6d.

THIS is a "teach yourself" book which introduces the most important branches of naval architecture and besides dealing with the basic principles, includes more advanced work with the intention of stimulating study. After defining the common terms, and briefly touching upon the lines plan there is a chapter concerned with calculations of areas, moments of inertia and volumes. This is followed by sections setting out the principles of both transverse and longitudinal stability and including a number of typical problems. Launching of ships is broadly treated, as is also the question of freeboard and of tonnage measurement. There is a chapter which treats longitudinal, transverse and local strength problems, and another which makes a quick survey of vibration, followed by an introduction to the resistance and powering of ships, and an overall examination of the design of propellers.

Stoff- und Wärmeübertragung in der Chemischen Kinetik. By D. A. FRANK-KAMENETZKI. Berlin - Göttingen - Heidelberg : Springer - Verlag, Berlin - Wilmersdorf, Heidelberger Platz 3. Price DM.28.50.

"MASS and Heat Transfer in Chemical Kinetics" was published in the original Russian edition in 1947 by the Institute of Physical Chemistry (Prof. N. N. Semenov) of the Academy of Sciences of the U.S.S.R., Moscow. The work which had not before been translated into German (an English translation was published by the Princeton University Press in 1955), deals particularly with aspects of research in which the author has himself been active, such as the influence of diffusion in solution processes and heterogeneous catalysis, stable and unstable combustion and oxydation reactions (flames and explosions), and periodic processes in chemically reacting systems.

Kältemaschinen-Regeln. Fifth Edition. By the Deutscher Kältetechnischer Verein (German Refrigeration Association). Verlag C. F. Müller, Karlsruhe : Price DM.29.

THE *Rules for Refrigeration Machines* of which previous editions appeared in 1922, 1929, 1940, and 1950, have now been issued in a completely revised form. The contents are not limited to a description of test procedures, but include theoretical foundations, and the properties of the most important refrigerants. This fact makes the handbook a welcome aid in the design, planning and calculation of refrigerating machinery and installations. After an introductory chapter on nomenclature and units, the handbook deals with performance guarantees, basic thermodynamic cycles, efficiency, output measurements, test procedures, accuracy of measurements, transition from test conditions to guaranteed performance conditions, examples of calculations and testing schedules, absorption machines, tables and diagrams of technical data, inter-conversion of metric and inch units, and standards specifications and regulations. Fifteen large-scale pull-out charts (Mollier diagrams and others) are appended.

Tensile Cracks in Reinforced Concrete. By AXEL EFSEN and HERBERT KRENCHEL. Laboratoriet for Bygningsteknik Danmarks Tekniske Höjskole Meddelelse Nr.9. Copenhagen : Research Laboratory of Building Technique, Technical University of Denmark. Price, Kr.8,00.

THE present paper which has previously appeared in *Ingenioren* (1959, No. 3) deals with an experimental investigation into the development of cracks in a large series of reinforced concrete specimens which were subjected to tension or to flexure. Factors which turned out to be of lesser importance were eliminated, and those of real significance were concentrated on. In most cases, cracks of 0·3mm–0·4mm are admissible, while special structures may call for an upper limit of 0·1mm. Since measurements of width at any single point cannot be made with an accuracy of more than $\pm$0·0025mm and cracks vary in widths along their length, this inherent lack of definition of the problem must be allowed for. It was possible to develop simple formulæ for the determination of cracks which are of practical interest.

Registrierinstrumente. By A. PALM. Second edition. Revised by H. Roth and E.-G. Schlosser. Berlin-Göttingen-Heidelberg : Springer - Verlag, Berlin - Wilmersdorf, Heidelberger Platz 3. Price DM.27.

THE advances made in the techniques of recording physical measurements since the present work first appeared in 1950 are important ones and of great interest to many engineers. The present compendium deals with the subject from the point of view of four main aspects : the means of recording, whether continuous or intermittent ; the clockwork and electric drives, and those drives utilising the quantity to be measured ; the transmission over a distance of the values measured, and a description of a large number of actual commercially available instruments. A final chapter discusses a variety of applications.

Spannungsoptische Untersuchungen von Turbinenscheiben mit angefrästen und eingesetzten Schaufeln. By KARL LEIST and JOSEPH WEBER. Forschungsberichte des Wirtschafts-und Verkehrsministeriums Nordrhein-Westfalen, No. 548. Cologne and Opladen : Westdeutscher Verlag, Opladen, Ophovener Strasse 1–3. Price DM.8.30.

THIS research report from the Institute for Turbo Machines of the Technical University, Aachen, compares the behaviour under rotation of discs with integral blades and with inserted blades (De Laval root). The method used is that of optical stress analysis applied to plastic models and the results are shown in the form of actual fringe photographs and plots in two and three dimensions.

Books Received

The Theory of Matrices. Vols. I and II. By F. R. Gantmacher. Chelsea Publishing Company, 50, East Fordham Road, New York 68, N.Y. Price 6 dollars each.

Electro-Technology for National Certificate Courses. Vol. 3. By H. Buckingham and E. M. Price. The English Universities Press, Ltd., 102, Newgate Street, London, E.C.1. Price 16s.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1

METHODS FOR SAMPLING LIQUID PETROLEUM PRODUCTS IN BULK STORAGE

No. 3195 : 1959. Price 4s. 6d. The sampling of petroleum products—for visual or laboratory examination or for preservation for record—is the subject of this publication. It deals with petroleum products contained in vertical fixed-roof tanks and horizontal cylindrical tanks maintained at or near atmospheric pressure. The methods are technically identical with the corresponding methods specified by the Institute of Petroleum.

Three procedures are included : the "weighted sampling can method" ; the "Sampling cage method" ; and the "Bottom sampling method." Special precautions to be observed when carrying out each test are described ; and a clause deals with general precautions relevant to all procedures. One clause defines the precise meanings of the various types of sample—"top sample," "single tank composite sample," and so on. Elsewhere are specified requirements for the various types of container : bottles and cans, together with their stoppers and closures. They are supplemented by instructions for labelling.

STEEL SHEETS FOR MAGNETIC CIRCUITS OF POWER ELECTRICAL APPARATUS. PART 1 : 1959 : NON-ORIENTED STEEL

No. 601 : 1959. Price 6s. This revised publication reflects advances in technology which have occurred since the first edition was issued twenty-four years ago. It will in due course be followed by Part 2, for oriented steel. Part 1 deals with non-oriented magnetic steel sheets and strip intended primarily for machines and transformers operating at power frequencies. It applies to material normally supplied in the fully processed condition—unless specifically ordered by the purchaser to be supplied in another form. Four appendices to the twenty-four-page specification deal respectively with method of testing total losses and total excitation, magnetisation measured by d.c. reversals, typical values for stacking factor, typical values for effect of ageing, bend test (brittleness). At the option of the purchaser, the fully processed material may be processed on one side only or on both.

HEALDS, HEALD FRAMES AND REEDS

No. 3182 : 1959. Price 6s. This publication deals with a range of cotton and wire healds, heald frames and pitch bound and metal reeds for use on looms for weaving natural and man-made fibre yarns. It specifies certain basic dimensions as well as the materials from which the items are manufactured ; but no specific recommendations are given for fixing the heald to the heald frames.

Indications are given of the healds and reeds which conform to provisional agreements of the International Standards Organisation (I.S.O.), and it is hoped to add at a later date details of wire heald frames that have been agreed internationally. The opportunity has been taken of including a standard system of measurement of reed counts which it is hoped will be generally adopted.

DIMENSIONS OF TAPERED ROLLER BEARINGS

No. 3134 : 1959. Price 5s. This publication is intended as a guide to manufacturers and to users in the choice of bearings of both inch and metric sizes. It contains fourteen dimensional tables, the majority of which are presented in association with "keyed" diagrams. The dimensions in all but two of the tables conform to the proposals submitted for the preparation of an I.S.O. international recommendation.

Technical Report

Some Methods of Calculating the Bending Strength of Plywood. By I. D. G. Lee, B.Sc. Timber Development Association, 21, College Hill, London, E.C.4.—This report is part of a study of the strength properties of plywood, by which it is hoped to assist designers in using more of the commercial plywoods now available. It compares some theoretical assumptions of the behaviour of plywood in bending and includes tables of geometrical properties of some British and Canadian plywoods. An appendix outlines the construction of an alignment chart for rapid comparison of the ultimate bending strengths of different plywoods.

Royal Institution of Naval Architects

ANNUAL SPRING MEETING

No. IV—(*Continued from page 644, April 15*)

THE second paper read on Thursday morning was :

TRANSVERSE STRENGTH OF SINGLE HULLED SHIPS ELASTIC ANALYSIS BY THE DISPLACEMENT METHOD USING AN ELECTRONIC COMPUTER

By I. M. YUILLE, B.Sc., PH.D., and L. B. WILSON, B.Sc.

SYNOPSIS

This paper describes a means of computation of the elastic strength of one ship compartment of any constant cross section, between two rigid bulkheads, under any system of loads applied in transverse planes. A program* has been written to enable the electronic computer "Pegasus" to take in data regarding the size and shape of compartment, the scantlings of its structural components and the loads applied, to use these to set up equilibrium equations in terms of displacements of the structure under load, and to solve them and print out the deflections and stresses.

The physical basis of the analysis and the method of solution are discussed and the scope and limitations of the computer program are stated. It is shown that good agreement was obtained between preliminary calculations and available experimental results. The equations upon which the work is based are derived in an Appendix.

DISCUSSION

Mr. R. H. Richards, R.C.N.C.: In their conclusions and recommendations, reference is made to a full size steel model of frigate type, 25ft beam, 15ft deep, and 69ft long. So far, single loads have been applied at positions along the keel, at the turn of the bilge and at the vertical ship side and the next load will be hydrostatic. One of the questions which these full-scale experiments will help to answer is that of rigidity at the bulkheads. The first experiments with this frigate model show that the bulkheads are not entirely rigid, but it is too early to say whether this effect is significant.

Further on in the conclusions and recommendations the authors state that the main object of the research work will be concerned with the effect on transverse strength of varying the numerous parameters. In support of this theoretical work, experiments are to be carried out on small scale models of the general type having variations in angle of rise of floor and radius of bilge.

The authors also state that the ultimate aim is to furnish the designer with information which will enable him to choose the best form of stiffening for a compartment, given its size and shape. One would like to think that this information will eventually take the handy form of curves drawn for the various parameters. If so, naval architects will find in the curves ready guidance as to scantlings and need only be concerned with a few check calculations.

Dr. J. B. Caldwell, B.Eng., Ph.D.: As to what the designer actually gives the computer to do, under the heading "The Computer Programme" the authors have set out the various scantlings one has to collect and offer to the computer. Most are fairly straightforward. But it is stated that the designer has to feed in the scantlings of the various members, transverse, diagonal and longitudinal bars, and this includes the effective width of plating ; I foresee difficulty in knowing how much we can regard as being effective. For a keel or a deep longitudinal it will be difficult to know how much of the plating acts in conjunction with that member in bending and shearing action. I think it probably stems from the way in which the authors have tackled the problem, by separating out the effects of shear and bending, and it might be more accurate to choose a method which did not separate them in this way.

Concerning the information the computer provides to the designer the authors have given tentative estimates of the time the computer will take to carry out the calculations, and it seems that we can expect a calculation time of two hours for one particular type of structure. Is it possible to reduce this time ? One way in which it might be done is to arrange for the computer to give rather less information than the authors have listed. It would be interesting to know how the new theory compares with conventional methods, and it would be most useful if the authors could include that comparison as an appendix to the paper.

Mr. Bull : I intend to restrict my remarks to the chapter concerning boundary conditions.

It seems to me to be an oversimplification to assume that the value of the coefficient of constraint, as proposed by Yuille in a previous paper, is the same at the bulkhead ends of each longitudinal. This is not the case ; in particular the coefficient of constraint of the vertical keel and the adjacent deep longitudinals will be different from that of the longitudinals above the turn of bilge and the deck girders. In addition the deformed shape of the longitudinals, and thus directly the value of the coefficient of constraint, will surely depend upon the loading in adjacent bulkhead spaces. For example, if the loading is due to hydrostatic pressure, the frame spacing uniform, and bulkheads approximately evenly spaced, then the longitudinals will behave as if they were encastré at the bulkheads, by symmetry. In the case of point loads due to machinery and other heavy weights in adjacent compartments, then the longitudinals will have an initial change of slope where they pass through the bulkhead which will not be the same for all longitudinals.

Thus for a given arrangement of structure I suggest that the values of the coefficient of constraint will depend largely on the particular type of loading under consideration, and may vary round the section.

Since the authors are dealing with stresses in the elastic range only, and thus considering small deflections, this would seem to have a significant effect on results, particularly where the number of frames is small and the bulkheads relatively close so that the support afforded by the longitudinals is of importance.

Whilst realising that the number of variables must be kept to a minimum in order to suit the computer program, I suggest that the coefficient of constraint be made variable. In order to offset the effect of this, one variable could be eliminated by keeping the spacing of the frames constant, since this is the condition most likely to be met in practice.

Dr. A. J. Johnson : This paper reveals the potentialities of modern electronic computers in the field of ship structural design and analysis. The agreement between the calculated deflections and stresses, and those measured on the xylonite model is most striking. Ultimately, of course, the test of a theory is in its application to the actual ship. It would be interesting to have the authors' views as to how far their methods might be applied to merchant ship construction. The differences between the type of section considered in the paper and that of a merchant ship are appreciable; a dry cargo ship has a substantial double bottom structure which is in effect a doubly plated grillage. The rise of floor is small and the transverse section inertia of the double bottom structure is so large in comparison with the section inertia of the side frames and their associated plating that the connections at the bilges may not be far removed from the pin-jointed condition in so far as the bottom structure is concerned. In the equivalent work being carried out by the British Shipbuilding Research Association the policy is to deal with the double bottom structure in the first instance. A large welded steel model of a typical longitudinally framed double bottom structure is now under construction. When the characteristics of this model under lateral loading have been determined it is the intention to build up the sides and decks to complete the three-dimensional structure. Early tests on pilot models have shown that under lateral loading the shear distortion of the double bottom may be of great importance.

I notice in the analysis that it is assumed that the transverse bulkheads at each end of the compartment are not displaced relative to each other by transverse loads. It is further assumed that longitudinal displacements are zero at all positions and this in turn leads to the condition that the longitudinals, together with a certain effective breadth of plating, have to resist bending only. The first of these assumptions is not strictly compatible with the second in that membrane stresses will arise from transverse loads.

On the question of the effective breadth of plating, the authors indicate that they have used values as recommended by Clarkson. Unfortunately, the document referred to has not been published and it would therefore be helpful if the authors would tell us what these recommendations are.

In conclusion, I would refer to the extensive program of full-scale tests undertaken some years ago under the direction of the Admiralty Ship Welding Committee. Transverse strength was not overlooked in these investigations and those concerned with this subject will find some interesting data in the H.M. Stationery Office publications dealing with the static bending tests on the "Ocean Vulcan" and "Clan Alpine." Transverse stresses were measured around the ship sections for a variety of loading conditions, including one in which the draughts were changed while the longitudinal bending moment was maintained sensibly constant.

Dr. W. Muckle, M.Sc., Ph.D. : I am interested in the work described in the paper because I have been attempting to approach the transverse strength problem in a similar fashion. I have been dealing with a merchant ship midship section which is virtually rectangular, so that there are some great differences as compared with the problem tackled here. One aspect which the authors have taken into account is that of shear. I would like to ask about shear deflection, whether this is a significant effect, whether there is very much deflection due to that

* In accordance with modern practice "program" has been spelt in this way to distinguish between a "program" which operates an electronic computer and a "programme" of work.

cause and whether shear could, as a first approximation, be eliminated from the calculation, thereby simplifying the results.

There is no doubt that the introduction of the computer has made a tremendous difference in tackling these problems, and it has enabled the general grillage problem to be tackled much more easily.

Other contributors have referred to the stiffness of longitudinals and the transverse frames. If we have a plate which is stiffened in two directions and is bending in both directions, what is the contribution of the plate to the keel section ? I think that might be ascertained or checked by a simple experiment.

Mr. H. Lackenby, M.Sc. : I am impressed by two things. First, by the agreement between the authors' experimental results and the results obtained by the new method of calculation described in the paper. Secondly, I was impressed by the extraordinary disagreement between their method of calculation and the old classical ring method. The authors' method of calculation, I take it, applied particularly to a warship, where the bulkheads are close together, by merchant ship standards. I have the feeling that, the merchant ship having a much longer compartment, the discrepancy between the authors' results and those obtained by the ring method may not be so great and the difference might close.

The final session of the spring meeting was held in the afternoon of Thursday, March 24, with Mr. L. Woollard, M.A., in the chair, and the reading of :

THE BEHAVIOUR OF THE SAILING YACHT

By H. M. Barkla, M.A., B.Sc.

Synopsis

The aerodynamic properties of yacht rigs are less well known than are the properties of hulls, but much can be learnt of the behaviour of yachts in general by combining a set of real hull measurements with synthetic sail coefficients based on the analogy of the aerofoil. Examination is made of the assumptions underlying the present procedure for interpreting tank-tests, and this is judged to be as sound as any of comparable simplicity, though the sail coefficients are not above criticism. Suggestions are made for their replacement and for an extension of the procedure which would yield, for a modest addition to the computing time, a more complete picture of the characteristics of a yacht from the same observations on the model.

A graphical method is described, by means of which many sailing problems may be quickly solved, giving a yacht's speed as a function of true course and true wind strength ; corrections for the direction and strength of the apparent wind are implicit, and this method is employed to examine the effect of varying some of the parameters separately ; the optimum true course is seen, for example, to depend largely on the power to which the resistance varies with speed.

Discussion

Mr. P. V. MacKinnon, M.A. : I approach this subject as a helmsman, with some knowledge of physics, who wishes to be helped in his task by the results produced by this work, and I welcome the author's methods and conclusions in the diagram in which he plotted speed made good against the angle between course and true wind. I should like to see the results plotted in a different manner, with the angle between course and true wind drawn as a polar co-ordinate.

The author states that he uses the angle of incidence as a convenient parameter. I suggest that a more convenient parameter would be the quantity C_T, and that all his calculations could equally well have been done if there were no angle of incidence given at all and C_T had been treated as the convenient parameter.

Concerning the optimum setting of the rig, the critical angle of heel at various speeds is a piece of information which the racing helmsman would like to be told.

Mr. Harrington Hudson : In the first part of the paper the author, speaking of sails, refers to the lack of experiments to show the lift and drag and how the position of the centre of effort varies with the angle of heel. He also states that rigid models cannot reproduce the effects of soft sails ; that the two components of the total aerodynamic force pass through one point irrespective of heel angle, and that current practice in tank testing assumes this constant arm for heeling moment.

I share these views and hope that a more realistic way of approaching the subject of testing soft sails, which I shall try to explain, may help future experimental work. A sail with no wind in it is a shapeless, limp canvas. It is the wind which transforms it into the shape for which it is cut, with correct flow, in which condition it assumes the aerodynamic properties of a rigid aerofoil. Wind, at a given speed and angle of incidence, on the sails of a yacht, will produce a certain angle of heel and a particular sail form in set and camber corresponding with that heel angle. For a given angle of incidence, heel angle and its corresponding sail form may in fact be linked together. A change of wind speed will produce a new heel angle and corresponding new sail form, and each sail form will have its own special resultant of wind force in strength and direction located at its own special centre of effort.

It seems to me that, in carrying out experimental work on models of soft sails, the exact sail form corresponding with the full-size sail under similar conditions of angles of incidence and heel, should be reproduced and, if this is done, useful information may be obtained. The scaling down to ensure this identical model sail form is simple and merely calls for a determination of the correct corresponding wind speed on the model sail, say, V_m, where V_y is the wind speed on the full-size yacht sail, n times larger than the model. We find that :

$$V_m = V_y/\sqrt{n}.$$

If, on the other hand, we apply the law of aerodynamic similarity with Reynolds number $1/\nu$ $V.L$ constant (applicable to rigid aerofoils and advocated in some wind tunnel tests on soft sails), the air stream in the wind tunnel may have to be raised to 60 knots, which would obviously deform the soft little sail out of all recognition or blow it to ribbons.

To prove my point, I constructed an exact scale model of a " Dragon " yacht and got a model yacht sail-maker to make sails in cotton and " Terylene." This model was floated in a small wind tunnel.

I selected a " Dragon " because some useful data had been furnished to me in the Yacht Research Council's second and last report on the performance of a " Dragon," which would enable me to position the exact C.G. of the model hull and check figures for wind speed and heel. I found that the model responded in the wind tunnel exactly as expected but, the scale being small, gauges had to be extremely sensitive to obtain results worth recording. The tests are in the initial stages but a few facts which seem to have been established by consistent repetition may be of interest : (1) when close-hauled, the centre of effort does not coincide with the centre of sail area, calculated geometrically, but lies well forward and higher than that centre. It rises as heel angle increases and falls and moves aft if the yacht bears away without easing sheets ; (2) the assumption that the heeling force acts normally to the mast appears to be correct up to the angle of heel at which wind spilling becomes obvious.

Mr. D. J. Doust, M.Sc. : This paper takes the reader on an excursion into the realms of theoretical yacht performance, so that one is able to calculate the effects of changes in wind strength, direction and boat speed on windward ability to a realistic order of accuracy.

Reference has been made to the " N.P.L. method of interpreting tank tests," a method which was in fact used by the late Professor Davidson in his early work. When yacht model tests were commenced at the N.P.L. the main issue involved was to compare quickly the relative performance of a few yachts of very similar proportions and sail area, and the assumption that β° is determined by the heel angle was considered to be sufficient for that purpose. At the present state of our knowledge, however, it is difficult to do more than accept the Gimcrack sail coefficients, amended perhaps to allow for modern rigs and use these as a generally accepted standard of performance.

It is not denied that any reliable quantitative comparisons of windward ability of yacht forms must rely on the results of tank tests for these forms, but unfortunately no uniform procedure for interpreting these results seems to be in current use. I commend the author's proposal to dispense with the Davidson Laboratory method, whereby the optimum speed made good to windward is derived by considering the performance of a yacht at constant boat speed and heel angle. If a yacht form is towed at constant boat speed and varying heel from a number of fixed positions covering the region of the centre of effort of the sails, the optimum speed made good to windward can be more accurately defined. For example, in the paper the optimum speed curve will be found to be the envelope of a series of V_{MG}–V_T curves, each having a slope more in keeping with the required curve, and for low wind speeds in particular, they will all coalesce. The D.L. technique is laborious, since the derivation of even the assumed centre of effort position from the model experiments, leads to lengthy calculations, as the model is towed in this case from a position very close to the waterline. There is also the possibility that small errors of measurements at this lower position can materially affect the derived position of the centre of effort, thereby affecting the derived trim, yaw and heel relationships.

The allowances proposed by the author for hull windage are to be commended, since in this way the indiscriminate application of the Gimcrack sail coefficient to all classes of sloop-rigged yachts is avoided. The interaction of the hull with the sails is a factor requiring immediate attention, but in the interim period the proposal given in the paper for modified sail coefficients could be adopted as a first order correction for variations in the ratio of hull profile area to sail area. It is unfortunate that, despite attempts to rationalise the interpretation of model and full-scale experiments with yacht forms, we still fall back on semi-graphical methods of analysis which should be avoided as an absolute measure of performance. The geometry of the vector diagram of wind velocities and the character of the V_{MG}–V_T curves suggests that these graphical methods might be replaced by a mathematical technique which could be programmed on an electronic computer.

The meeting was concluded with the presentation of papers Nos. 9 and 10 which were discussed together and were :

FULL-SCALE TANK TESTS OF AN INTERNATIONAL 10 SQUARE METRE CLASS CANOE

By T. Tanner, A.C.G.I.

Synopsis

When a sailing yacht is "on the wind" the hull produces a resultant hydrodynamic force of which the component parallel to the direction of motion through the water (drag) is very much less than the component at right angles to it (lift). The magnitudes of these force components and the relationships between them depend upon the shape of the vessel and upon the speed and angle of leeway. The paper describes full-scale tank tests to measure the forces on an international 10 square metre class canoe fitted in turn with six different centre-boards. It appears from the results that while the lift component is very little different from what might be expected by the application of the aerodynamic theory of thin wings of large aspect ratio, the drag is considerably greater. Of the centre-boards tested the most effective shape appears to be of thin aerofoil section. The effect of a sharp leading edge was to increase the drag.

THE GEOMETRY OF SAILING TO WINDWARD

By T. Tanner, A.C.G.I.

Synopsis

The ability of a sailing yacht to beat to windward depends on its velocity relative to the air and to the water and upon the aerodynamic and hydrodynamic forces developed as a result of these velocities. The relationships between these various velocities, their directions and some of the forces are expressed in analytical form and are illustrated by means of graphs. A method of estimating the optimum speed to windward from a detailed knowledge of the aerodynamic and hydrodynamic characteristics of the vessel is developed and is illustrated by figures taken from wind tunnel tests on a model sail and tank tests on a hull.

Discussion

Mr. W. A. Crago, B.Sc.: I believe Mr. Tanner's paper is unique in that it presents data obtained from towing tank tests on a full-scale yacht. With regard to Mr. Tanner's experiments, certain inferences can be drawn from his diagram showing variation of drag/(speed)^2 with speed (no yaw) which could affect the interpretation put on the rest of the data. We have re-analysed the drag/(speed)^2 spots for the hull alone and presented them in rather more conventional terms. From the shape and location of the curve we obtained, relative to the I.T.T.C. (1957) model-ship correlation line and by comparison with other data presented on the same co-ordinates, it may be inferred that the flow in the boundary layer was substantially turbulent at all the speeds represented by the spots in Mr. Tanner's diagram. Furthermore, it is a reasonable assumption that laminar flow would not have asserted itself when the hull was yawed, so that the resistance variation with yaw over the range of yaw angles considered would not be discontinuous.

If this is accepted, the difference between Mr. Tanner's curves, representing respectively the hull and a profile, may be regarded as solely due to the fin keel. This difference has been analysed in terms of C_F (based on the fin wetted area) and plotted against Reynolds number (based on the fin chord), and it is immediately apparent that the results suggest a large proportion of laminar flow (persisting up to more than 80 per cent of the fin chord in one case). Presumably interference between the hull and keel contributes to the total resistance, but its magnitude is evidently small.

It would seem that such a large proportion of laminar flow is rather unlikely, but if the data are accepted at their face value there are further repercussions when the fin was yawed. One could expect laminar flow to persist on the fin up to some small angle and then turbulence to occur. My conclusion is that the data imply large experimental errors, and if the original test data could be tabulated, no doubt the truth of this could be ascertained.

A practical comment concerns the measurement of yaw angles on a yacht at sea. I would suggest that much of the difficulty experienced with the tests on the Fairey "Firefly" may have been due to the shape of the towed weight. Recent experience at Saunders-Roe suggests that experiments should be made to ensure that any proposed towed weight has suitable static and dynamic stability characteristics.

Mr. F. Brooks: If you take a conventional keel boat with a fairly high aspect ratio, the function of heel angle is a very critical part of the actual speed made good to windward. Likewise the trim angle plays a very important part. Observations of water speed against heel angle and trim angle at sea are interesting. I should like to see another set of curves showing the water speed against heel angle, with the trim angle included. Further, if the figures could be transferred to tank tests some interesting results would accrue in respect of drag factors.

Mr. D. J. Doust, M.Sc.: The results given by the author are related to the full-scale hull, and are thereby directly applicable without scale effect corrections. This approach seems to offer considerable advantages in solving some of the main hydrodynamic problems. Every care seems to have been taken in the tests, and it is disappointing that the lift forces from the keels exceed the theoretical values, although this might be explained by a reduction in effective speed ratio of the keels at higher speeds. One wonders whether the theoretical values of induced drag are strictly applicable to the case of aerofoils working in a region subjected to excessive wave-making resistance and consequent deformation of the fluid boundaries, since although the specific effect of the main hull on lift and drag has been allowed for in deducing that of the keels, the hydrodynamic flow below the main hull still cannot be regarded as two-dimensional. Furthermore, since the main hull contributes only about 2½ per cent of the measured lift forces, compared with 50–90 per cent of the measured drag forces, it follows that the differences of relatively large quantities are involved in determining the induced keel drag, making them less accurate on this account.

In my experience the oscillations in the yaw measurements, particularly at the higher speeds and yaw angles, could explain most of the scatter in measured drag force shown in these results, and it is perhaps significant that for the lower speeds and small angles of yaw the measured drag forces approach more closely to the theoretical drag curve shown by Mr. Tanner. For this reason the yaw measuring device used in the original N.P.L. yacht dynamometer was made as rigidly as possible, although still allowing a fractional torsional movement to enable the out-of-balance couple which arises in the horizontal plane of measurement to be determined.

In the author's second paper, he has extended the theory of yacht performance sailing to windward, referred to in the discussion of a paper on this subject read before the Institution in 1957. The experimental work, conducted by towing a full-scale international canoe in a tank and relating the measured lift and drag forces to those obtained from tests on a Bermudan mainsail in a wind tunnel, is much to be commended. This direct approach by-passes the difficulties involved when scaling up from model experiments, and also disposes of some of the difficulties inherent in the use of the Gimcrack sail coefficients given by Davidson.

I endorse the concept of considering the hull and sail forces in the directions parallel and normal to that of the velocity of the hull relative to still water (V_s). One basic objection, however, to the definitions of F_{RW} and $(F_H \cos\theta)_w$ used by the author is that they both include the area of the sails, whereas, being hydrodynamic forces, they should more properly be functions of the shape and wetted area of the hull. Although these definitions yield solutions to the equilibrium condition when both resultant sail and hull forces are parallel and of the same magnitude, it is considered that these hydrodynamic forces on the hull should be related to the more truly dependent variables.

Referring to the more practical case of a yacht advancing to windward, when both heeled and yawed, one wonders how the author's method for zero heel can best be extended. When simulating the close-hauled sailing condition in a towing tank, the model (or full-scale yacht) can be towed at constant speed from a series of points covering the region of the true centre of effort of the sails. For each towing point and speed, equilibrium will be established at a series of combinations of values of resistance and lateral forces, heel, trim, yaw and the restoring moment measured in a horizontal plane. Only when we come to identify these equilibrium conditions with the full-scale wind velocities derived from sail data is there any major difficulty.

The difficulties in correctly simulating the aerodynamic conditions of a full-scale rig in a wind tunnel undoubtedly explain the paucity of reliable information on this subject. Some of the most important of these are the porosity of the sails, the effects of the boom and rigging, the variations in sail shape which occur on the full scale with variations in trim, heel and sail incidence, and the wind gradient above the water surface, which is one of constant pressure. Despite these difficulties, it is considered that some initial basic data on the relationship between C_v and C_H would materially assist yacht designers in applying the results of tank tests to full-scale conditions.

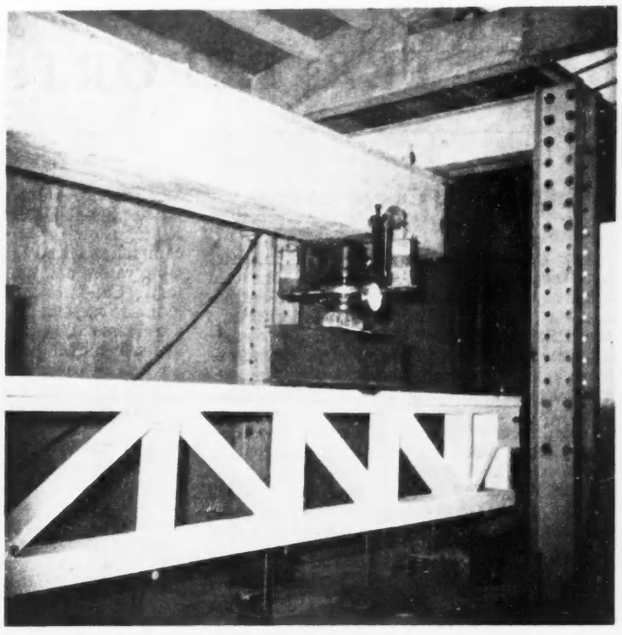
Codes of Practice

THE STRUCTURAL USE OF PRESTRESSED CONCRETE IN BUILDINGS

Code 115 : 1959. The first Code of Practice to deal with prestressed concrete, CP.115, provides the authoritative guidance necessary for the general adoption of this form of construction. The new publication is limited to the use of prestressed concrete in buildings ; but many of its recommendations have a wider range of application. The design of concrete mixes is based on a specified requirement for strength. Permissible stresses in the steel and concrete and values for calculating losses of prestress are given for the design of beams, slabs, columns and composite and continuous construction —for the conditions arising during prestressing operations, during construction and under working loads. For beams and other flexural members a load factor against failure is defined as an additional requirement, and a method for calculating ultimate strength is recommended. Some guidance is provided on the use of secondary reinforcement and on the fire resistance of beams and slabs.

Other recommendations relate to the design, use and maintenance of prestressing equipment and to the materials and methods of grouting cable cavities. The practical aspects of concreting, formwork and treatment of prestressing steel are also dealt with. To assist in design, an appendix gives information on bond lengths obtained in the production of members with pretensioned steel.

CP.115 was prepared by a committee convened on behalf of the Council for Codes of Practice by the Institution of Structural Engineers.



LEFT. Demonstration erection of a three-storey precast frame, clad with panels which combine structural and decorative functions. A demonstration erection of this frame after trial erection and dismantling was achieved in three hours. The design is noteworthy for the inclusion of electrical services in the hollow floor slab, and for its overall simplicity. The floor slabs span 35ft; "wet joints" are at a minimum and there are none on the outside of the building. RIGHT. Test rig for an experimental "N"-braced beam. This type of beam is being assessed for its suitability in buildings where a double floor/ceiling construction is called for, so that extensive services can be accommodated in the space between

Precast Concrete Manufacture at a Hounslow Works

FAIRLY rapid evolution has been evident over the past few years in the uses for which factory-made elements of precast concrete are employed. More ambitious sizes, particularly in structural concrete, are more in evidence, and total production, too, is on the increase. These trends can be illustrated by recent production at one large works in the London area, that of Concrete, Ltd., at Hounslow. At this works production now runs at about 10,000 square yards of flooring, plus about 20,000 cubic feet of other products, per week. The tendency is towards the greater use of prestressing, and about 75 per cent of this output is in prestressed concrete. A new casting shop using the familiar long-line pretensioning has recently been brought into use. This shop is remarkable more for the simplicity of its layout and equipment than for novel technical refinements, for such a straightforward layout is convenient for high rates of production. The precast elements—generally large floor slabs or piles—are allowed to mature on the casting beds for sixteen hours before the wires are released, and the shutters struck. A noteworthy point is the installation of underfloor heating, using steam pipes, which helps to cure the elements during this critical period.

The accompanying illustrations show two aspects of the firm's work which are of especial interest. The precast frame shown partially erected is considered to be somewhere near the ultimate in simplicity, and it is probable that no further refinement is possible in the use of precast concrete for a frame of this kind. The floor slabs are hollow pretensioned elements; each is 3ft 4in wide and 13½in deep, and they have a clear span of 35ft. Such a span is now commonly used with these pretensioned elements, and is about double the spans which were most customary a year or two ago. In this case a flexible system of electrical services is incorporated, by running leads through the central hollows of selected slabs between junction boxes. A collar can then be fixed into the slab at any point, to give a telephone or power connection.

The slabs rest on reinforced concrete beams, which are actually combined beams and facing panels. There are, in fact, two such elements to be seen at each floor level in the illustration. They are 4ft 11½in high, over the facing panel, by 12ft 5½in long, and faced with exposed black granite aggregate. Complicated shapes such as these, and in this frame the columns as well, for which relatively few castings are needed, are constructed in reinforced concrete. Prestressing is concentrated on the simple, mass-produced shapes.

The columns are 34ft high and 15in by 10in in section. They incorporate ducts formed with pitch-fibre pipes for rainwater and for services. The columns have a steel baseplate and are positioned with holding-down bolts just like a steel stanchion. Angle-iron or channel-iron bearing brackets are cast into them at the various floor levels and similar projecting angle or channel shapes give a steel-to-steel seating of the beams on the columns. The joint is completed by an *in-situ* filling, but is shaped so that it is internal. As the frame is shown in the illustration, neither the welding of the steel-to-steel junction nor the concreting of the *in-situ* filling of the joints have been carried out.

The tie of each roof truss is pretensioned, and the rest of the truss is precast on to the tie after the latter has been prestressed. This applies equally to the bottom boom of the "N"-braced beam shown in the second illustration. About half of this beam can be seen, the test set-up using the normal four-point loading.

A building about 200ft long is to be erected at Manningtree, in Essex, using the frame design described here. Another development is a design for a twenty-one storey frame.

Automatic Warehouse Dispensing

FORMATION of a new company, Solartron–John Brown Automation, Ltd., to manufacture and install the Gumpertz system of automatic warehouse dispensing in all continents except America was announced on April 8. The company is jointly owned by The Solartron Electronic Group, Ltd., and John Brown and Co., Ltd., and has its offices at 20, Eastbourne Terrace, London, W.2. It was stated that the system was aimed at the warehouse handling a large number of lines and more than 1000 orders a day, and it was estimated that an installation made in appropriate conditions would pay off its capital cost in about four years. In the Gumpertz system the warehouse is fitted with rows of steeply sloping shelves from which packages are delivered by the opening of electromagnetically-operated barriers on to endless belts. These deliver through diverter gates on to the packing belts which convey articles to the packing stations. The form taken by the electronic control system is flexible. It may accept inputs in the form of punched cards or tape, or by direct character-reading. There is parallel access from the computing equipment to all shelves. Time for making up individual orders averages fifteen seconds. One important application foreseen is in "supermarkets," where customers could hand in cards representing the articles required. These would simultaneously feed the order into the control equipment and cause the total price to be displayed to the customer and the cashier. On payment being made, the cashier would press a "release" button and the stored demands would at once be transmitted to the warehouse. While particularly suitable for packaged articles, the system could be applied to others, subject to their size and weight, being suitable for delivery from the shelves and transport along the conveyors. During the making up of an order the equipment automatically regulates the flow of goods to prevent conflicting movements, and maintain steady deliveries. A pharmaceutical warehouse in the United States is stated to have paid for itself in two years, and to have had only ten minutes lost time in that period.

[Reply Card No. E6892]

SHORTER REPORTS

International Co-ordination of Time Signals

THE United Kingdom and the United States have begun co-ordination of their time and frequency transmissions by radio. Co-ordination was begun early this year in order to help provide a uniform system of time and frequency transmissions, which is needed in the solution of many scientific and technical problems in such fields as radio communications, geodesy, and the tracking of artificial satellites. Participating in the project are the Royal Greenwich Observatory, the National Physical Laboratory, and the Post Office Engineering Department in the United Kingdom, and, in the United States, the U.S. Naval Observatory, the Naval Research Laboratory, and the National Bureau of Standards. This programme follows previous co-operative efforts of these agencies to achieve uniformity and simplification in procedures.

The transmitting stations which are included in the co-ordination plan are GBR and MSF at Rugby; NBA, Canal Zone; WWV, Beltsville, Maryland; and WWVH, Hawaii. Co-ordination began in January. It is expected that by the end of 1960 the time signals from all the participating stations will be emitted in synchronism to the thousandth of a second. Such accuracy has been needed for some time in tracking artificial satellites on a world-wide basis.

The service of international radio time signals controlled by the Royal Observatory and transmitted by the Post Office radio station GBR at Rugby on a frequency of 16 kc/s was inaugurated in 1927. Since 1942 the signals have also been emitted by various short-wave transmitters in order to ensure, in association with GBR, a reasonable measure of world coverage. The frequencies employed are changed as required every two or three months in accord with the predicted ionospheric conditions. The signals comprise a five-minute series of seconds dots (approximately one-tenth of a second long) with the minute signals lengthened approximately half a second long) from 0955 to 1000 G.M.T. and from 1755 to 1800 G.M.T. The GBZ transmitter at Criggion (19·6 kc/s) serves as a standby in case of non-availability of GBR.

Standard frequency transmissions from Rugby MSF have been in operation since 1950. Transmissions on 2·5, 5 and 10 Mc/s are continuous except for a break between fifteen and twenty minutes past each hour. In addition there is a transmission on 60 kc/s from 1429 to 1530 G.M.T. The present MSF schedule provides in each quarter-hour ten minutes of seconds pulses (the minute pulses being lengthened), four minutes of unmodulated carrier, and one minute of speech announcement. The pulses consist of five cycles of the 1000 c/s tone, which is derived by dividing the frequency of the quartz ring standard controlling the carrier wave. They thus have the full precision of this standard and the rate defined by the time signals corresponds to the carrier frequencies.

The carrier frequencies of all the MSF transmitters and also of GBR are controlled by the same ring crystal oscillator and are calibrated to an accuracy of ± 2 in 10^{10} by the caesium standard at the National Physical Laboratory. From April 1 the master oscillator has also been used to control the time signal dots of GBR and its associated short wave transmitters. Owing to differences in the control circuits, there will be small differences between the times of emission of time signals on the various transmitters, but these should remain sensibly constant. The reserve station GBZ at Criggion is being equipped with control equipment to maintain the international radio time signals in case of major breakdown at Rugby.

The master oscillators controlling the carrier frequencies and time signal dots of the United States services from WWV, Beltsville, Maryland; NBA, Summit, Canal Zone, and WWVH, Kihei, Hawaii, will be adjusted to the same common standard agreed between the U.S. Naval Observatory and the Royal Greenwich Observatory. Calibration of the oscillators will be in terms of caesium standards in the U.S.A. which are compared by radio with the caesium standard at the National Physical Laboratory. Towards the end of each year, the United States Naval Observatory and the Royal Greenwich Observatory will assess the frequencies of the U.S. and U.K. caesium standards in terms of the current value of Universal Time 2 as determined by astronomical observations. These values will be adopted and used in both countries for the control of the frequencies of the radio transmitters and the "rate" of the time signals.

Astronomical observations for the determination of time are made at the R.G.O. with a photographic zenith tube, and by the U.S.N.O. with similar instruments, but differing in detailed design, at Washington and Richmond, Florida. The instrument at Herstmonceux was designed by the observatory in collaboration with Sir Howard Grubb, Parsons and Co., Ltd., who made it, and has since made similar instruments for observatories elsewhere. It has been in regular use since November, 1955. All essential parts were designed to keep the instrumental errors within a tolerance of 1 millisecond. Experience has shown that the probable error of a typical night's work, including instrumental errors, the uncertainties arising from errors in the tabulated positions of the stars and from atmospheric irregularities, is about 3 milliseconds. The photographic zenith tube observations are used to assess the errors and rates of the master clocks, which are housed in individual temperature-controlled cellars under the new West Building at Herstmonceux. All the clocks are quartz crystal, and are automatically checked not only among themselves, but also with similar quartz clocks at the N.P.L. and at the P.O. laboratories which are connected to Herstmonceux by permanent Post Office lines. Comparisons made at the N.P.L. between the quartz clocks and the caesium atomic resonator are used in comparing the astronomical observations with the caesium frequency standard. Radio reception and time measuring equipment in the Time Service Control Room at Herstmonceux is used to monitor the radio transmissions and thus to determine the errors of the radio time signals.

Prestressed Concrete Road Bridge at Hobart, Tasmania

A CONTRACT has recently been let for the construction of a prestressed concrete road bridge for the Department of Public Works, Hobart. The bridge will be a major structure costing about £3,000,000; it will be 4649ft long, spanning the River Derwent, with approach viaducts on both banks. The main bridge is 3364ft in length, comprising a main navigation span of 310ft, two flanking spans of 197ft, thirteen spans of 140ft on the west side and six similar spans on the east side. The main navigation span will comprise a suspended span 98ft in length supported on cantilevers each 106ft long, extending from the adjacent 197ft spans. The remainder of the bridge will be a series of continuous spans.

The deck structure will comprise six parallel precast concrete beams with strands post-tensioned by the Gifford-Udall system and with a composite precast and *in situ* deck slab. The deck beams will be carried on crossheads mounted on prestressed concrete columns which will, in the case of the four piers supporting the navigation spans, be of box section and resisting horizontal thrusts.

An interesting feature of the remainder of the structure over the river, namely, the series of continuous 140ft spans on either side of the navigation section, is that the comparatively large deck movements resulting from temperature changes, shrinkage and creep, will be absorbed by flexure of the supporting columns which will be of slender prestressed concrete construction, precast and post-tensioned by the Lee McCall system, fixed at the base and hinged at the top.

Each of the twenty-one river spans is to be founded on a group of vertical and raking bored reinforced concrete piles of 4ft 6in diameter, varying in length up to 170ft and driven through up to 90ft of alluvial deposits to the underlying rock. The maximum depth of water is about 120ft. The piers flanking the main navigation span will incorporate massive gravity fenders, giving protection against shipping impacts.

The main abutments will be substantial reinforced concrete structures designed to resist the overturning moments resulting from longitudinal and lateral forces in the bridge deck.

Piling will be carried out using a floating steel template which will be anchored to massive concrete blocks resting on the river bed and holding the floating structure below the range of tidal movement. This template will also provide shuttering to the soffit of the pile caps.

The erection of the superstructure will be carried out using structural steel column and beam units of lattice construction, which will be erected on pontoons and floated out to the bridge site, then supported on the pile caps. This will carry heavy lifting plant capable of dealing with precast beam and column units up to 100 tons in weight. The constructional work is due to be completed in 1963.

The consulting engineers to the Tasmanian Government are Messrs. G. Maunsell and Partners, of London and Melbourne. Messrs. E. W. H. Gifford and Partners, of Southampton, are associated with them for the design of the deck. The main contractors are Reed and Mallik, Ltd., of Salisbury, and Braithwaite and Co., Engineers, Ltd., of London.

Preventing Acidic Smut Emission from Boiler Flues

To meet the problem of acidic smut emission from the chimneys of oil or pulverised coal-fired boilers, a system of injecting additives into the flue gases has been developed by Dust Control Processes, Ltd., 161, Clarence Street, Kingston-upon-Thames, Surrey. In introducing this system the firm points out that smut emission from boilers is primarily caused by the high SO_3 content of the gases and the consequent high dew-point temperature which results in local condensation on cold sections of flues and particularly stacks and the deposition in these sections of very fine greasy particles which build up into loose agglomerates. These agglomerates adhere only very lightly to the flue and stack surfaces so that the slightest variation in gas velocity will entrain them in the gas stream in the form of smuts or sooty flakes. These smuts are of such a size that the majority of them settle within 50 yards or so of the normal stack and the resulting damage can be considerable, not so much because of the black and greasy nature of these deposits, but principally because of their high acid content.

The system of dealing with this problem is to inject into the boiler flue gases a controlled concentration of a finely divided alkaline hygroscopic precipitate, the particles of which provide nuclei for the absorption of acid and the very fine greasy particles. About 100 million particles are injected per cubic foot of flue gas and these are subjected to a high degree of turbulence, to ensure, in the first stage, the most intimate

mixing and contact of the powder and gases and, in the second stage, the maximum agglomeration of the enlarged particles. The agglomerated particles are then extracted from the gas stream by centrifugation in a specially designed dust collector. An important advantage claimed for the system is the neutralising of the acidity of the gases and the entrained particles, which results in the inhibition of corrosion and the reduction of the dew-point temperature of the gases.

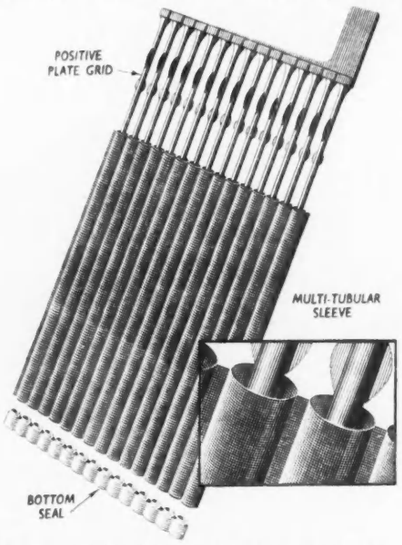
The precipitate is injected into the boiler flue by an insufflator at a controlled rate and under conditions which ensure intimate mixing of the powder and flue gases. Low-pressure air admitted into the powder chamber of the insufflator carries a controlled amount of powder into the upper part of the unit where an adjustable ejector delivers into it a controlled quantity of low-pressure primary air. The resulting mixture of powder-laden air is then injected into the boiler flue through what is termed a "Turbulator," which promotes intimate mixing of the powder and gases by dispersing the particles over a very wide area as a result of a high carrier air exit velocity.

The " Turbocell " dust collector used with the system incorporates a number of cells through which the treated gases flow on their way to the chimney stack. Each cell is fitted with an insert having curved vanes which impart a swirling motion to the gases, causing them to deposit suspended particles on the cylindrical cell sides to then gravitate down into a dust hopper.

[Reply Card No. E6903]

Traction Batteries

REFERENCE was made in a paper on battery electric vehicles read to the Canadian Electrical Association in Quebec earlier this year (see our January 29 issue) to the low-weight and long-life characteristics of the latest form of " Exide-Ironclad " traction battery. This incorporates a new " Gauntlet " construction of the positive plates, the principles of which we now illustrate.



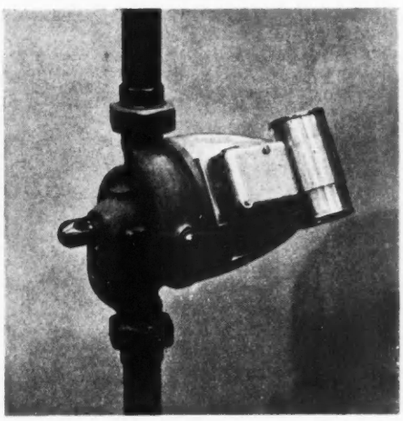
Battery positive plate showing spines, plastic sleeve and bottom moulding

It will be seen that the characteristic tubular plate form of the " Exide-Ironclad " battery, made by Chloride Batteries, Ltd., Exide Works, Clifton Junction, Manchester, has been retained, but a multi-tubular sleeve of " Terylene " holds the active material in place. In the previous " Exide-Ironclad " battery the positive plates consisted of finely-slitted ebonite tubes containing the active material around a conducting core of CB.95 alloy. The same alloy forms the grid of the present plate, and it will be noted that spacers on the rods locate them inside the " Terylene " sleeves. The elasticity of the sleeves facilitates movement with the volume changes which take place in the active material through each operation cycle, without risk of fatigue failure. It has been calculated by a battery vehicle manufacturer that the reduction in size and weight of these batteries would allow an increase in payload, depending on the size and description of vehicle, of from 20 to 25 per cent without increase in cost. The polythene moulding at the bottom of the plate seals the " Gauntlet " sleeves and also serves as a corrosion-resistant insulator.

[Reply Card No. E6911]

Central Heating System Accelerator

AN accelerator for small bore domestic forced circulation central heating systems is now made by Lee Howl and Co., Ltd., of Tipton, in two models—one having a capacity of 7½ gallons at 2ft head and 3½ gallons at 4ft head, the other model being of 12 gallons capacity at a 2ft head and 2 gallons at a 7ft head. The accelerators are designed to handle water up to 270 deg. Fah. and are fitted with a capacitor-start-and-run single-phase motor with which



Hot water accelerator for central heating systems

practically a full torque load is available at starting on normal voltage.

These accelerators are installed, as shown in the illustration, with their shafts set horizontally, although their branches may point in any direction. The terminal box and condenser on the outside of the casing can be fitted on either side to comply with installation requirements. The units have a cast iron casing, a stainless steel shaft and a bearing housing of aluminium alloy, the total weight being 15 lb. A self-cleaning filter incorporated ensures that the sleeve bearings receive a constant supply of clean filtered water during operation to give a long, effective working life.

[Reply Card No. E6912]

Interrupted-Potential Oxygen Analyser

A NEW instrument for the analysis of oxygen concentration in gases and liquids, including blood and other biological fluids, has been developed by British Oxygen Research and Development, Ltd., Deer Park Road, Wimbledon, London, S.W.19. This instrument operates on a principle known as " potential interruption," in which the final measurement used in determining the oxygen concentration is one of potential difference and not diffusion current. One advantage of this method is that it minimises the problems associated with oxygen diffusion and usage at the electrode surface ; another is that, because the results do not depend on the electrode area, very small electrodes can be used.

The analyser measures the amount of charge lost by a solid platinum micro-electrode through electro-chemical reduction of oxygen at the electrode surface : the electrode is charged, the source of charge removed, and the fall in charge in a fixed time interval is measured on a high-impedance voltmeter. The sequence, which is repetitive, is controlled by an automatic electronic switch. To reduce the passage of current through the cell, the electrode is charged by a condenser. The sensitivity can be altered by a four-position selector switch, giving full-scale deflections ranging from oxygen concentrations of 0–2 per cent to 0–100 per cent. The apparatus is stated to be accurate to within ±2 per cent. The presence of anæsthetic vapours—such as ether, cyclypropane, fluothane and trichlorethylene—have no effect on the electrode performance. The instrument's speed of response depends to a large extent on the design of the electrode but response time is easily reduced to under ten seconds.

A production version of this analyser is expected to be available in a few months' time and will be marketed by the Medical Division of British Oxygen Gases, Ltd.

[Reply Card No. E6913]

Industrial Electronics Conference

DETAILS have been announced of the three-day conference on " User Experience of Electronics in Industry " which the Electronic Forum for Industry is to hold at Olympia, London, on May 24, 25 and 26, when the Instruments, Electronics and Automation Exhibition is in progress. Subjects and speakers at the conference will be as follows :

Session 1, *May* 24.—" Electronics in Data Processing": C. W. Barnard, Esso Refinery, Fawley ; A. J. Platt, Pilkington Brothers, Ltd., St. Helens ; R. G. Jecks, Legal and General Assurance Society, Ltd.

Session 2, *May* 25.—" Electronics in Factory Applications": O. T. Smith, Dunlop Wheel and Rubber Company, Ltd., on " Electronic Machine Tool Control at Work " ; K. Teale, Short Brothers and Harland, Ltd., on " The Development of Numerically Controlled Machine Tools " ; T. A. Cogan, The Ford Motor Company, Ltd. (subject to be announced) ; W. H. Davies, Steel Company of Wales, Ltd., on " Electronics in the Steel Industry."

Session 3, *May* 26.—" Electronics in Instrumentation and Control": J. M. Keating, B.P. Trading Company, Ltd., on " Instrumentation " ; F. C. Allister, McVitie and Price, Ltd., on " Handling and Proportioning " ; P. H. Dixon, Peter Dixon and Son, Ltd., on " Continuous Control of Electrical Machines " ; A. G. Coates, Iraq Petroleum Company, Ltd., on " Remote Control and Telemetry."

All sessions will begin at 2.30 p.m. Tickets for the conference, at £1 11s. 6d. per session, are obtainable from the Honorary Secretary, E.F.F.I., c/o The Electronic Engineering Association, 11, Green Street, London, W.1.

Computer Society Conference

THE second annual conference of the British Computer Society, Ltd., will be held in the Sun Pavilion, Harrogate, from July 4 to 7. A provisional programme has been issued of events extending from the opening address at 5.30 p.m. on July 4 to the official luncheon and closure at 1 p.m. on July 7. Morning and afternoon sessions on July 5 and 6 will be occupied by the presentation of five papers and two symposia, and a final paper and symposium will be presented in the morning session of July 7. Subjects include : " Progress Towards a Common Language for Computers," " The Use of Computers in Market Research and Statistical Analysis," and " Simulation Studies in Process Control and Planning." The symposia will review the role of small computers in science and industry, numerical analysis, and accounting applications. A civic reception will be held on the evening of July 5. Fees for members of the society are £1 10s. and for non-members £5 (excluding accommodation and tickets for the official luncheon). Requests for application forms should be made to Miss E. D. Pilling, The Electronic Computing Laboratory, The University, Leeds, 2.

SHORTER REPORTS *(Continued)*

Instrumented Water Treatment at Willington "A" Power Station

A NEW system of instrumentation for water treatment is in operation at the C.E.G.B. Willington "A" power station near Derby. It is designed to reduce plant outage caused by evaporator scaling or carbon-dioxide corrosion. This installation, which was made to the requirements of the C.E.G.B., by Honeywell Controls, Ltd., Greenford, Middlesex, is designed to co-ordinate the control of flow and pH value in such a way that the pH value of the water entering the evaporators is kept at a predetermined value to give optimum working conditions.

The control system regulates the action of a two-stage treatment plant supplied by the Neckar Water Softener Company, Ltd., whereby incoming town's water is initially softened in a base exchange softener and then dosed with an automatically controlled flow of acid to decompose the bi-carbonate present. The acidified softened water is then fed into a degassing tower where the free carbon dioxide is liberated. The degassed water, which still contains a trace of carbon dioxide together with a slight excess of acid, is then drawn off from the degassing tower sump and alkali is injected to a required pH before the finally treated water is pumped to storage tanks and thence fed to the evaporators.

Two views of the control equipment are reproduced below. An orifice plate and differential pressure transmitter measure the flow of water through the whole plant. This flow is recorded and integrated and automatically controlled by means of a diaphragm control valve. Liquid level in the degassing tower is also indicated and controlled pneumatically with a diaphragm control valve. The pH value is recorded and pneumatically controlled for both stages of the treatment process. The method of control is novel in that flow and pH control are co-ordinated by the use of averaging relays.

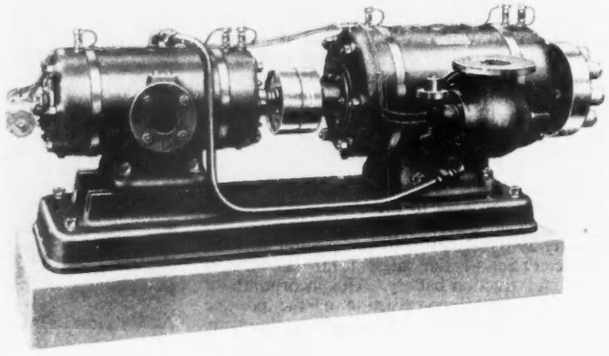
The rate of acid dosing is governed by the average of the signal from the liquid level controller (approximately proportional to flow) and the controlled air output from the pH controller. A second relay, which is manually adjustable, allows the acid dosage rate to be varied to accommodate changes in the total alkalinity of the untreated town's water. The acid dosing system can thus be reset to suit the varying qualities of the feed-water from different sources in the Derby area. The alkali dosing rate is governed by the average of the flow transmitter signal and the controlled air output of the second pH controller.

The new control system has been found to keep the pH value constant to within 0·2 pH.

[Reply Card No. E6921]

Rotary Air Compressors

A RANGE of rotary air compressors is now made under a licence acquired from a French manufacturer by Belliss and Morcom, Ltd., of Birmingham, and a typical two-stage machine can be seen in our illustration. These compressors cover outputs from 100 to 600 cubic feet per minute, and up to 50 lb per square inch with single-stage or 110 lb per square inch with two-stage machines. They are of vane design, having a ported cylinder cast in one piece integral with water jacket, inlet and outlet branches, and feet. The cylinder-head castings which bolt directly on to each end of the cylinder are also water cooled and carry the main shaft bearings in addition to forming part of the shaft packing housing. Heavy-duty precision roller bearings carry the rotor shaft, which is fitted with plastics axial seals which are self-adjusting for wear. Lubrication to the cylinder and bearings is provided by an oil pump, with individual adjustment to each point.

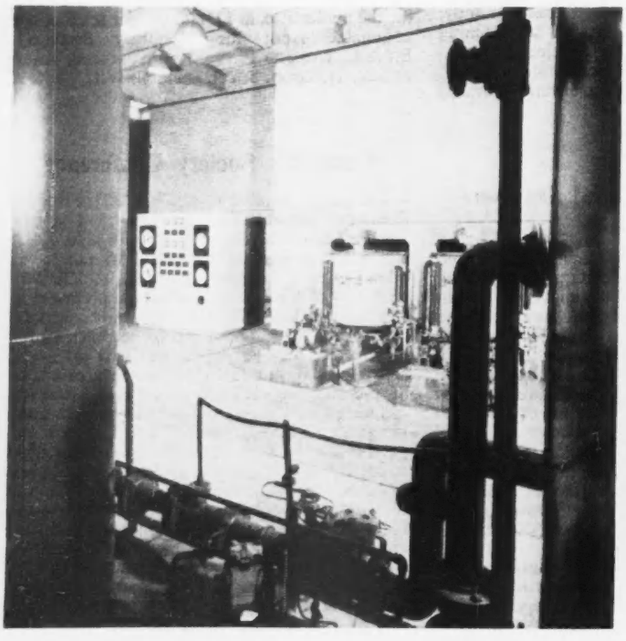


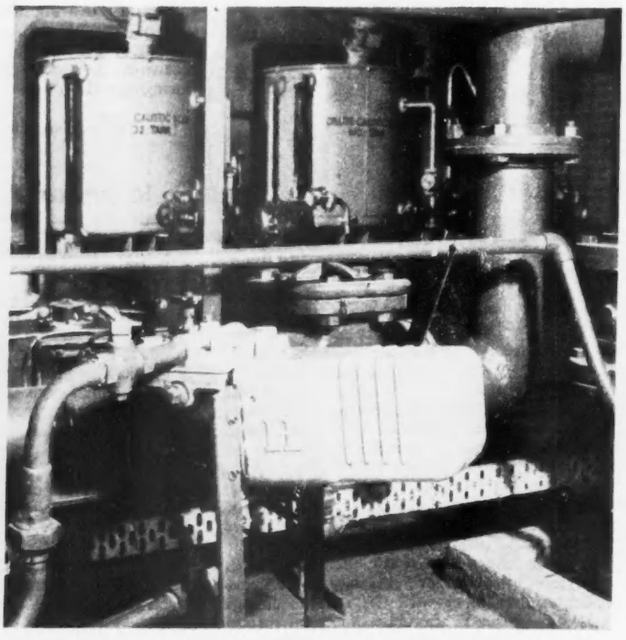
Two-stage rotary air compressor

The standard compressors have one or two stages in line, but the number of cylinder sizes available makes possible other arrangements of stages and cylinders to meet most requirements for air compressors, gas compressors, boosters and vacuum pumps. On normal two-stage machines an intercooler is fitted to reduce the air inlet temperature to the second stage and to remove some of the moisture in the air.

When an a.c. constant-speed motor drive is used, as is the common practice, control is usually accomplished by fitting an automatic inlet control valve. This valve shuts off the intake air to the compressor when the selected working pressure has been exceeded by 3 to 5 per cent and re-opens when the pressure has dropped to normal, which means that the compressor is either at full load and efficiency or running light. The automatic air discharge release gear opens the delivery branch to atmosphere, keeping the light running power to a minimum. A relay mechanism actuated from the discharge side of the delivery non-return valve operates the inlet control valve, and is adjustable to vary the pressure at which the control valve operates.

[Reply Card No. E6922]





(Left) Instrument panel for controlling the water treatment at Willington "A," power station, Derybshire. (Right) A differential converter-transmitter in the water treatment room of the power station

Heavy Duty Wheeled Tractor

At a recent demonstration of contractors' plant held by Thos. W. Ward, Ltd., of Sheffield, there was shown for the first time in public the prototype of a wheeled tractor developed by Marshall Sons and Co., Ltd., of Gainsborough, for the War Office. This 4×4 tractor has a drawbar pull of 20,000 lb in first gear and, when fitted with the 9ft 6in wide blade of the hydraulically operated bulldozer equipment shown in our illustration, it weighs about 32,000 lb.

The tractor has a six-cylinder Leyland engine rated at 145 b.h.p. at 1800 r.p.m., developing 495ft lb torque at 1000 r.p.m. It is fitted with a fluid flywheel and drive is transmitted to all wheels through epicyclic hub reduction gears, a single differential being fitted to ensure freedom from diagonal wheel spin. The five-speed pre-selective, air-operated, epicycle gearbox is fitted with high/low ratio and overall reverse control. In first gear with low ratio the vehicle speed is 2·4 m.p.h. and in top gear high ratio 32·6 m.p.h.

145 b.h.p. four-wheel drive, four-wheel steering tractor with a drawbar pull of 20,000 lb

Four-wheel steering with power assistance is provided for the tractor but manual steering is also possible, the turning circle overall diameter being just under 40ft. All wheels have pedal-operated compressed air/hydraulic brakes and a hand-operated disc brake is fitted to the transmission. Air is provided for the braking and gear changing mechanisms by an engine-driven compressor which delivers into two air reservoirs of large capacity.

The ancillary equipment available with the tractor includes a double chain cable control unit driven from the rear end power take-off, a hydraulically-operated recovery winch, a hydraulically-operated loading shovel and the bulldozer to be seen in the illustration.

[Reply Card No. E6931]

Multi-Point Temperature Scanner

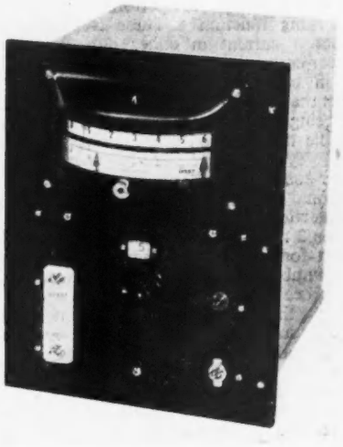
Production has begun by West Instrument, Ltd., 52, Regent Street, Brighton, 1, of a scanning equipment for monitoring temperatures at a number of different points. Scanning is effected by connecting the sensing devices in turn to a moving coil millivoltmeter through an enclosed assembly of cam-operated mercury switches with synchronous-motor drive. This arrangement has been chosen instead of uniselectors because it was considered that the latter might disturb the system by the effects of contact resistance and corrosion. Up to twelve points can be monitored in succession. The scanning time is one minute, so that individual temperatures are displayed on the meter for a minimum of five seconds.

Sensing is by means of thermocouples or resistance bulbs according to the temperatures involved. Generally speaking, thermocouple sensing is effective above 200 deg. Cent. and a resistance bulb is used below that temperature, but the methods of obtaining temperature readings are flexible and may be varied for particular applications. In the resistance bulb instrument the mains supply is rectified and stabilised within the unit to give a d.c. source.

The instruments can be arranged for two modes of action. A single maximum temperature can be pre-set on the scale and, if the temperature at any of the scanned points reaches this, scanning stops and an alarm or trip action to shut down the machinery comes into operation. In the second arrangement, two temperatures can be set on the scale. If the temperatures scanned reach the lower point, a relay is operated and makes the contact for an alarm; then, if the temperature reaches the second limit, a trip action is initiated.

In the accompanying illustration the setting knob is seen immediately below the scales. This can be withdrawn after the instrument is set up to prevent unauthorised alteration of the settings. The point being scanned at any moment is shown in the small window in the centre of the panel, and below this is the knob for manual operation of the scanning cycle when required. Automatic or manual scanning is selected by means of the "start" and "manual" push buttons on the left of the panel. An equipment of this kind, consisting of four scanners and eighteen alarm and trip points with resistance thermometer sensing, has been supplied for proposed application to the generating plant of the linear particle accelerator at Harwell.

[Reply Card No. E6932]

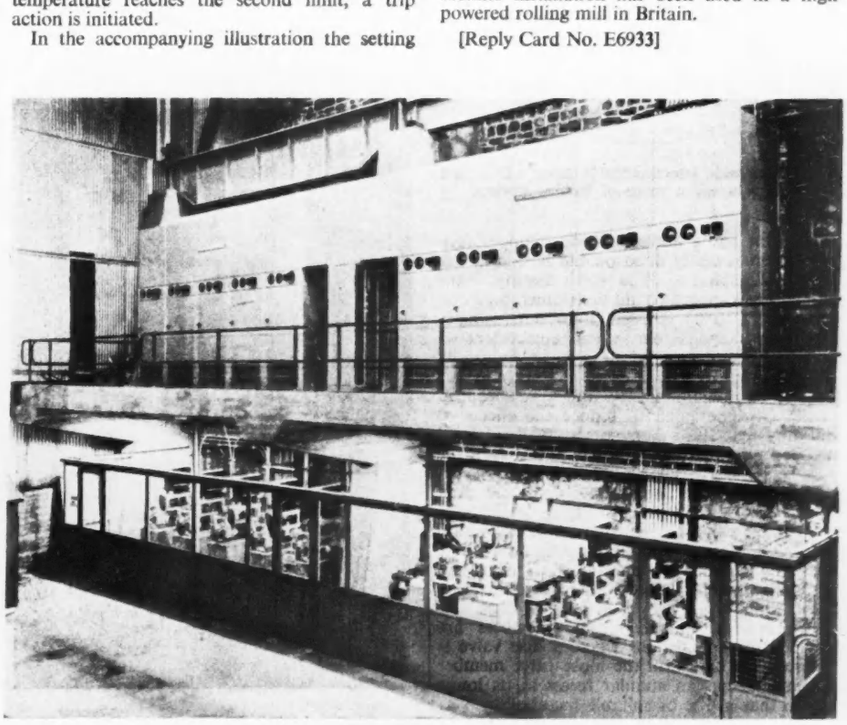


Temperature indicating and alarm unit with multi-point scanning through cam-operated mercury switches

Mercury-Arc Converter for Steel Mill

A mercury-arc rectifier/inverter equipment supplying a 4000 h.p. reversing billet mill drive has recently been commissioned by Associated Electrical Industries, Ltd., at the Stocksbridge works of Samuel Fox and Co., Ltd. The equipment is made up of pumpless steel-tank mercury-arc rectifier/inverters, with an r.m.s. rating of 3200kW and a voltage range of 0 to 900V, and is situated, with its associated grid-control cubicle equipment, on the gallery in the motor room. Anode reactors for each rectifier tank are mounted in frames above and integral with the rectifier cubicles. All the tanks are provided with full thermostatic temperature control. The twelve-phase, 66kV rectifier transformer is installed in a separate sub-station. D.C. circuit breakers are mounted immediately below, on the floor of the motor room, together with a fast-acting armature reversal switch. A laminated-yoke exciter supplies the existing motor field. The control gear, housed in cubicles, comprises static amplifiers, transistorised sequence control systems, supervisory instrumentation and alarm equipment. A closed-loop system of speed control is included in the equipment, with over-riding limitation of current, voltage and acceleration. On both a.c. and d.c. circuits, there is adequate protection in case of failure through over-current, backfires, and other faults. It is believed to be the first time that this kind of rectifier installation has been used in a high-powered rolling mill in Britain.

[Reply Card No. E6933]



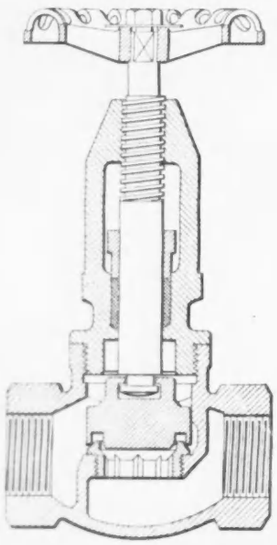
3200kW mercury-arc rectifier/inverter installation (with d.c. circuit breakers at floor level) in motor room of reversing billet mill at Samuel Fox and Co.'s Stocksbridge works

SHORTER REPORTS *(Continued)*

Multi-Purpose Globe Valves

A GLOBE valve designed for quick and easy adaptation for all common factory services, using two interchangeable parts, has just been introduced by Bells Asbestos and Engineering Company, Ltd., Slough, Bucks, in a range of sizes from ¼in to 3in. These valves are made with either screwed or flanged connections and are suitable for working temperatures up to 500 deg. Fah., with steam at pressures up to 250 lb per square inch, or working cold at pressures up to 400 lb per square inch. They have a gunmetal body, a manganese bronze screwed spindle and a plastic-coated cast iron handwheel. Into this standard body there can be fitted any of six trims of loose valves and seats to suit particular applications. The universal design of control and stop valve thus provided is easily maintained and, when used throughout a factory system, requires the storage of a minimum number of spares.

The range of loose valves and seats available covers the requirements of common factory services such as steam, water, air, gas. The construction of a typical valve is shown in the drawing we reproduce. The loose valve member



Globe valve with interchangeable loose valves and seatings to suit a range of factory services

of the trim has a horseshoe-slotted upper face by which it is easily fitted on the button at the end of the spindle. The valve seatings have eight grooves spaced round their inner bores to enable them to be screwed in or out, using a square or octagonal bar, when replacement or servicing is necessary.

The seat and valve fitted in the body in our drawing are of stainless steel and have shrouded seating faces designed to reduce the effects of wire-drawing and damage from suspended foreign matter. In a somewhat similar trim the loose valve has a needle extension to give an increased degree of fine and accurate control in a line. For normal process steam applications the stainless valve and seat have a 45 deg. mitre knife-edge seating and for conditions where excessive wire-drawing prevails these trims can be supplied with " Stellite " inserts in the seating faces.

Two sets of interchangeable members are provided for applications where a disc valve is required. In one form the loose valve member of gunmetal has an annular recess in its lower face so that a disc of suitable material such as asbestos, rubber, composition, copper or white metal can be fitted to provide the seal. The other form of disc valve is adaptable for use with low-pressure steam, water, gas or other services compatible with gunmetal at temperatures up to 400 deg. Fah. Its recessed loose valve seat is fitted with a " Viton " rubber O-ring giving effective sealing against the seat with a minimum of effort when screwing down. A simple nut and washer used to hold the O-rings and sealing discs in position allows for quick and easy renewal when servicing the valves.

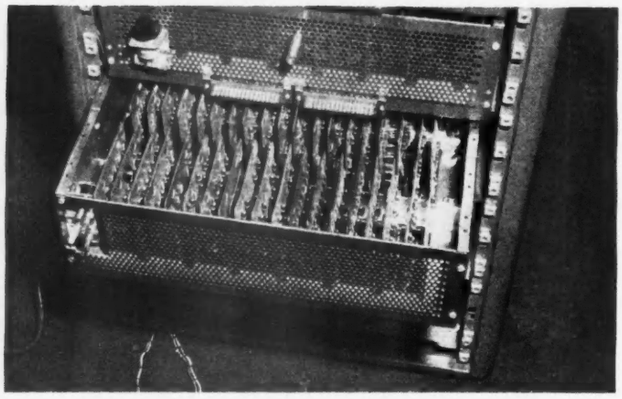
[Reply Card No. E6941]

Transportable Digital Computer

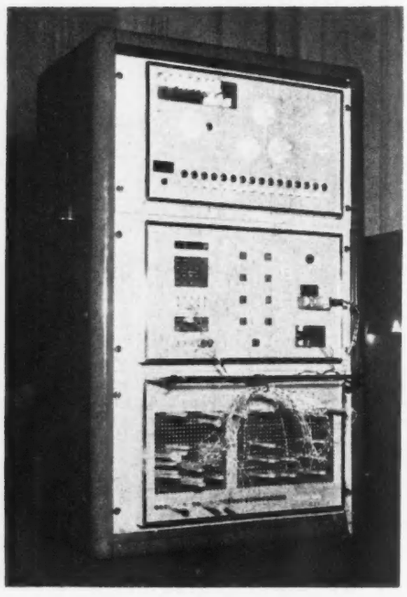
WORK on computers at the Royal Aircraft Establishment, Farnborough, led to the conclusion that a digital machine working in increments might be simpler than one working in whole numbers as is usual. A class of machines known as differential analysers has therefore been developed, and one of these, the " Corsair " computer, was demonstrated in London on April 6. The differential analyser deals with information of a continuously variable nature such as is normally handled by analogue machines. In this it has the advantage in speed over digital computers working with whole numbers, for while the latter might calculate a continuous function every $^{1}/_{10}$ second the " Corsair " will do so every 1/500 second.

The most suitable mathematical process for the differential analyser is integration, and it can integrate with respect to other variables as well as time. In the " Corsair " a considerable reduction in volume has been achieved compared with analogue machines of equivalent capacity. There are fifty integrators, and the machine handles fifteen-digit numbers. As seen in the illustration of the complete machine, a patch panel similar to that of an analogue computer is used so that operators accustomed to analogue procedure may adapt themselves to working with " Corsair " with very little trouble. Input in the prototype is by means of push-buttons, but the design also allows for punched cards.

A technique responsible for much of the space-saving achieved in " Corsair " is the use of SB240 surface barrier transistors in the single arithmetic unit. At the demonstration last week the form of circuitry made possible by these devices was described by representatives of Semiconductors, Ltd., Cheney Manor, Swindon, Wiltshire, by whom they are made. It was shown how elements of the active store, such as flip-flops, can form a direct-coupled logic, with the elimination (compared with conventional practice) of six components in each circuit and of a bias supply. Throughout the arithmetic unit, capacitors and resistances for limiting saturation become unnecessary. This part of the computer contains 680 surface barrier transistors connected according to the direct-coupled technique. They will operate in this application at switching speeds up to 4 Mc/s. The controlled saturation characteristics of the SB240 transistor are derived from an automatic electro-chemical production process developed by the Philco Corporation of America and used by Semiconductors, Ltd., as described in our October 31, 1958, issue.



Arithmetic unit of differential analyser, showing printed circuit boards carrying surface barrier transistors



A " Corsair " computer of the differential analyser class built by the Royal Aircraft Establishment, Farnborough

The main store in the computer is a ferrite core matrix using TK 20 reversible switching transistors supplied by Standard Telephones and Cables, Ltd.; having bidirectional characteristics they are able to perform both reading and writing functions. These transistors will conduct a current in either direction in the collector-emitter circuit. Their essential difference in construction from the unidirectional form is that instead of the collector-base junction area being much larger than the emitter-base area, the two junction areas are approximately equal. Typically, the ratio of the normal to inverse common emitter current gain of a unidirectional transistor is of the order of 10 : 1. In bidirectional transistors this ratio generally lies between 2 : 3 and 3 : 2. Information is read in parallel form, but the arithmetic unit works in serial numbers, digits being taken sequentially in time, processed, and returned for storage.

Part of the arithmetic unit with printed boards carrying surface barrier transistors is seen in the second illustration. Although still an experimental machine, the " Corsair " computer has been developed already in a form which would be suitable for commercial application. Its size and weight would make it suitable for airborne service, possibly to meet certain navigational requirements.

[Reply Card No. E6942]

INDUSTRIAL NEWS

Iron and Steel

British iron and steel production was maintained, during March, at the high rate achieved in February. Pig iron output in March averaged 312,300 tons a week, and over the first quarter of this year was 36 per cent higher than in the comparable period of 1959. Steel output in March averaged 485,100 tons a week and was thus running at an annual production rate of 25,226,000 tons, compared with a rate of 18,060,000 tons in March, 1959. Steel production in the first quarter of this year was 35 per cent higher than in the first quarter of 1959.

The Iron and Steel Board, commenting on these figures, points out that an important constituent in the total steel production is alloy steel. During the first quarter of this year, the production of alloy steel ingots and castings averaged 32,600 tons a week, or nearly 7 per cent of the total output of crude steel. During the preceding ten years, the output of alloy steel had remained in the neighbourhood of 6 per cent of the total, although during the war years it reached 12 per cent. But it should be kept in mind that steel output during the war years was little more than half the present rate. Within the field of alloy steel, the production of stainless steels has been increasing in importance. The output of these steels during the first quarter of this year averaged 5160 tons a week, which is equivalent to 15·8 per cent of the alloy steel production. The current pressure of demand springs from the growth of civil applications of alloy steel. The increasing importance of these new uses has meant that capacity for the production of alloy steels is fully occupied once more and delivery dates are extended. Recently, the Iron and Steel Board says, new steel-making and rolling capacity has been installed and further schemes are in prospect to meet the expected growth in demand for alloy steels.

Collaboration on Power Plant Research

General agreement has been reached between Associated Electrical Industries, Ltd., and A. Reyrolle and Co., Ltd., and C. A. Parsons and Co., Ltd., for a joint programme of research and for the exchange of technical information and experience in the field of generating plant and ancillary equipment. In a letter to the stockholders of A.E.I., Ltd., Lord Chandos, chairman of the company, explained that this collaboration would lead to economies, both in capital and in current expenditure on research, and at the same time make the joint research more effective. In these circumstances, while the three companies would continue to trade in competition, a financial link between them appeared to be desirable. The letter gave the following details of the financial arrangements.

"At present Reyrolle owns 40 per cent of the Ordinary Shares in Parsons, and A.E.I. has agreed to acquire from Reyrolle half its shareholding amounting to 1,800,000 Ordinary Shares of £1 each, being 20 per cent of the Parsons issued ordinary share capital. In return, A.E.I. will issue to Reyrolle, 1,525,000 Ordinary Shares of £1 each credited as fully paid from its unissued capital. After this transaction the issued ordinary capital of A.E.I. will total £42,828,595, of which the shares issued to Reyrolle will represent just over 3½ per cent. A.E.I. will not receive any dividend for the year 1959 on the Parsons shares acquired from Reyrolle, nor will the new A.E.I. shares to be issued to Reyrolle rank for dividend in respect of the year 1959."

The Case for Coal

The National Coal Board is sending to industrialists, architects, local authorities and hospital management boards, a booklet entitled *The Case for Coal* which is designed to appeal to industrial and commercial consumers, who between them use about 50,000,000 tons of coal a year. The booklet asserts that progressive industry is "going forward on coal," and says that Britain's indigenous fuel can be the economical answer to most industrialists' fuel needs.

The booklet goes on to point out that modern techniques have revolutionised methods of burning coal. Smoke can be eliminated with modern combustion methods, waste can be cut, and problems of handling solved. Nowadays, it is observed, the boiler house can be as spick and span as a modern kitchen, and the boilers can work automatically. Coal can be burnt in a smoke control area when mechanical stokers are used ; and the cost of steam-raising, it is claimed, will be lower in the majority of cases than with any other kind of fuel. The modernised coal industry, the Board declares, is in a position to ensure that the mining, preparation and delivery of coal is geared to meet the needs of the most demanding industrial consumer. The industry can also offer its customers a free advisory service. The booklet has devoted a page each to industrialists, to architects and consulting engineers, to works engineers, and to local authorities, reminding them of the most effective methods of using coal in their own particular fields ; another page explains how the Clean Air Act works.

Machine Tool Orders

The Machine Tool Trades Association has published the final results of its metal-working machine tools inquiry for the year 1959. The figures show that the 1958 trend of shrinking order books and declining deliveries continued in the early months of last year. But in the second quarter, with the pace of economic expansion at home and abroad quickening, there was a sharp reversal in the trend of net new orders received and the value of orders on hand ceased to fall. Net new orders increased further during the second half of last year, with new orders from the home market predominating although there was also some increase in export orders. This upward trend in net new orders received continued into January of this year.

The Association goes on to say that machine tool deliveries last year naturally reacted more slowly, with some expansion in the second and third quarters and a more rapid growth in the fourth quarter. During the year as a whole, the value of total deliveries was 6 per cent less than a year earlier, but in the fourth quarter it was 10 per cent greater than in the comparable quarter of 1958. Although total deliveries in January of this year were lower than those of December, they were 15 per cent higher than a year earlier. At the end of January total machine tool orders on hand were 5 per cent more and export orders were 3 per cent more in value than at the end of last year.

British Machine Tools

The "ill-conceived criticism" of the British machine tool industry is commented on by Colonel C. W. Clark in his annual statement as chairman of Alfred Herbert, Ltd. The industry's critics, he says, show little real knowledge of the complexity of production technique covered by the term "machine tools," which embraces more than 1000 types and sizes of machines for the cutting, abrading or forming of a wide variety of materials. The many different processes performed by these machines, which can weigh anything from 100 lb to several hundred tons, make the term "machine tools" no more descriptive than, say, the word "vehicle," which can cover anything from a "Centurion" tank to a baby's pram ! As an example of the danger of thoughtless generalisation about machine tools, the statement continues, a proposal which may have merit if applied to a complicated high-production machine becomes ludicrously inappropriate when considered for the commoner general purpose machines, or vice versa.

Toxic Substances in Factory Atmospheres

Measures for the protection of workers against the inhalation of dusts or fumes or other impurities likely to be injurious are discussed in a booklet entitled *Toxic Substances in Factory Atmospheres*, which has been published by the Ministry of Labour. This booklet is one of a series designed to give information and advice about questions of safety, health and welfare in industry. It is obtainable (price 1s.) from H.M. Stationery Office.

The booklet emphasises that it is of prime importance always to be on the look-out for a possible hazard, and to bear in mind the possible need for precautions. A toxic substance should, wherever possible, be replaced by a harmless one or, failing this, a less harmful substance. Where a toxic substance must be used, and substitution is impossible or only partially possible, the best protection is in the total enclosure of the process or plant, or failing that, the use of the "fume cupboard" principle familiar in chemical laboratories. "Built in" safety precautions are always preferable to personal protective equipment, but in cases in which toxic dusts or fumes cannot be adequately controlled by any of the methods discussed in the booklet, appropriate respirators or breathing apparatus should be provided and worn. The need to wear protective clothing, and for thorough washing of exposed parts of the body are emphasised as means of protection against toxic materials which can be absorbed through the skin. The booklet gives figures of maximum permissible concentrations of certain substances used in industry as a guide to which the efficiency of control measures should be related. These figures are subject to revision in the light of increasing scientific knowledge, and amendments to the list will be published from time to time.

PERSONAL AND BUSINESS

Appointments

MR. C. F. WATTS has been appointed a director of Wickman, Ltd.

SIR JOHN EVETTS has been appointed to the board of Dowty Fuel Systems, Ltd.

MR. A. C. BALL and MR. A. E. GILBERT have been appointed directors of Hayward Tyler and Co., Ltd.

MR. JOHN H. WHITAKER, A.M.I.Mech.E., has been appointed sales manager of Hagan Controls, Ltd.

RUSTON AND HORNSBY, Ltd., has announced the appointment of Mr. C. J. Hind as engineering director.

MR. G. R. T. LANGFORD-ALLEN has been appointed general manager and director of Palmer's Reinforced Plastics, Ltd.

MR. A. D. R. WATSON, A.M.I.C.E., has been appointed district engineer, Inverness, Scottish Region British Railways.

MR. R. D. PEARCE has been appointed a director of Keeton, Sons and Co., Ltd., a member of the Firth Cleveland Group.

MR. A. F. SHAW has been appointed regional manager of the north-west region of Associated Industrial Consultants, Ltd.

W. H. ALLEN SONS AND CO., Ltd., announces that Mr. J. W. Boddy, A.M.I.Mech.E., and Mr. P. C. Saltmarsh have been appointed to the board of directors.

MR. W. A. COLLINS has joined the Electric Construction Company, Ltd., as sales engineer attached to the East Midlands area offices, 90, Knowle Lane, Sheffield, 11.

THE AUSTRALIAN ATOMIC ENERGY COMMISSION has announced the appointment of Dr. George Clifford James Dalton as director of the Lucas Heights Research Establishment.

THE TEMPERED SPRING COMPANY, Ltd., announces the appointment of Mr. Eric Larner as manager of a new division created for handling the "Rollpin," a spring-type cylindrical fastener.

INTERNATIONAL HARVESTER COMPANY OF GREAT BRITAIN, Ltd., states that Mr. D. C. Haney has been appointed assistant managing director. Mr. H. D. Frymire succeeds Mr. Haney as director of sales.

MIDLAND SILICONES, Ltd., announces that Mr. J. E. Monaghan has been appointed manager of the rubber sales department at the London sales headquarters. The appointment becomes effective on May 2.

BRITISH STANDARDS INSTITUTION announces that Mr. C. A. Zweigbergk, M.I.E.E., has been appointed director of the British Electrical Approvals Board for Domestic Appliances. He takes up his duties on June 1.

SIR RONALD L. PRAIN has relinquished the chairmanship of the management committee of the Copper Development Association after ten years in that office. He has been succeeded by Mr. E. C. Baring.

DR. CECIL DANNATT, M.I.E.E., has been appointed vice-chairman of Associated Electrical Industries, Ltd., with the special responsibility of co-ordinating both commercial and technical policy. Mr. H. West has succeeded Dr. Dannatt as managing director of Associated Electrical Industries (Manchester), Ltd.

THE BRITISH PETROLEUM COMPANY, Ltd., announces that Sir Neville Gass, having reached normal retirement age, is relinquishing his appointment as chairman on June 30. The Hon. M. R. Bridgeman has been appointed chairman, and Mr. J. M. Pattinson, deputy chairman, and it is intended to appoint Mr. M. A. L. Banks to fill the vacancy on the board caused by the retirement of Sir Neville Gass. These appointments will be effective from July 1.

Business Announcements

CIMEX-FRASER TUSON, Ltd., Cray Avenue, Orpington, Kent, has changed its name to Cimex, Ltd.

THE LOMOUNT GROUP OF COMPANIES has opened new offices at Sackville House, 40, Piccadilly, London, W.1.

MR. J. G. WINDOW, sales director of Q.V.F., Ltd., is making a three-week visit to Spain, Portugal and Italy.

SIMMS MOTOR UNITS, Ltd., has opened a new branch at 114-126, Westmoor Street, London, S.E.7 (telephone, Greenwich 6226/7/8).

THE BRITISH ASSOCIATION OF CORROSION ENGINEERS, 97, Old Brompton Road, South Kensington, London, S.W.7, has been elected a member of the European Federation of Corrosion.

RANSOME AND MARLES BEARING COMPANY, Ltd., states that its Leicester area office is to move from Great Central Street to De Montfort House, 223, Belgrave Gate, Leicester.

FREDERICK BRABY AND CO., Ltd., states that the address of its head office, registered office and transfer office is now Braby House, Smithfield Street, London, E.C.1 (telephone, Central 2388).

THE CHAMBERLAIN GROUP OF COMPANIES, 3, Buckingham Palace Gardens, London, S.W.1, states that it has acquired the north country civil engineering and railway contracting firm of Grant, Lyon and Co., Ltd.

MONSANTO CHEMICALS, Ltd., has announced that, at his own request, Sir William Garrett relinquished his executive responsibilities with the company on April 1, in order to devote more time to his other interests. He will continue as a member of the board.

ANGLO-SWISS SCREW COMPANY, Ltd., Trout Road, West Drayton, Middlesex, has announced that it now has a Birmingham area office in operation at Windsor Chambers, 367a, Bearwood Road, Smethwick, 41, Staffs (telephone, Bearwood 2799), under the control of Mr. A. K. Hughes.

FOUNDRY AND METALLURGICAL EQUIPMENT COMPANY, Ltd., Netherby, Queens Road, Weybridge, Surrey, has made arrangements with Beno Schilde A.G. of Bad Hersfeld, Germany, to manufacture and to market in Great Britain and Ireland, drying equipment operating on the Beno Schilde system.

ALBI-WILLESDEN, Ltd., 6, De Vere Gardens, London, W.8, states that it has concluded a licence agreement with Hadfields (Merton), Ltd., to manufacture and sell in the United Kingdom a new fire retardant surface coating, "Albisaf." Hadfields' three associated companies, Foster Mason and Harvey, Ltd., Charles Morrison Compositions Company, Ltd., and Zocus Compositions and Paint, Ltd., will also act as United Kingdom distributors. Graham and Wylie, Ltd., Glasgow, will sell "Albisaf" in Scotland.

THE SIMMS MOTOR AND ELECTRONICS CORPORATION, Ltd., Oak Lane, East Finchley, London, N.2, announces that in order to augment its existing electronics interests, it has acquired for cash the whole of the issued capital in Cawkell Research and Electronics, Ltd., Scotts Road, Southall, Middlesex. Mr. G. E. Liardet, chairman of Simms Motor and Electronics Corporation, Ltd., is now chairman of the Cawkell company and other directors are Mr. M. A. Hassid, deputy chairman of the parent company, Mr. J. Ayres, Mr. K. G. Smith, Mr. A. E. Cawkell, who is also general manager, and Mr. R. D. Stafford, works director.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., has announced that a new ammonia plant, with a capacity of 100,000 tons a year, and associated plants to make urea and fertilisers, will be built at its Severnside works in South Gloucestershire, at a cost of upwards of £10,000,000. These plants are expected to start production during 1963. I.C.I. has also decided to extend the methanol plant at its Heysham works in Lancashire. A new plant to make 30,000 tons a year of methanol began production there only a few months ago. A further extension to make an additional 45,000 tons per year is now to be built, and is expected to be completed during 1962.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., has announced the formation of a new company, Telcon Metals, Ltd., Crawley. This company has assumed responsibility for all the activities of the metals division of The Telegraph Construction and Maintenance Company, Ltd. The board of directors of the new company consists of: Mr. W. C. Handley, M.I.E.E., chairman; Mr. W. F. Randall, M.I.E.E., deputy chairman and managing director; Dr. G. A. V. Sowter, M.I.E.E., commercial director; Dr. H. H. Scholefield, technical director; Mr. D. Norman-Thomas, and Mr. L. D. Dodd, secretary. In addition to operating the factory at Crawley, Telcon Metals, Ltd., will control the following subsidiary companies: Magnetic and Electrical Alloys, Ltd., Burnbank, Hamilton, Lanarkshire; Telcon-Magnetic Cores, Ltd., Chapelhall, Lanarkshire; Temco, Ltd., Lydbrook, Glos; Toolpro, Ltd., Ilford, Essex.

MODERN WHEEL DRIVE, Ltd., Lindo Lodge, Stanley Avenue, Chesham, Bucks, states that a licence and manufacturing agreement has been concluded between Etablissments Robert Messian of Paris and Cambrai, and Mr. Thomas Hindmarch, for the manufacture in France of Hindmarch M.W.D. marine transmissions. These transmissions are manufactured in England by Modern Wheel Drive, Ltd.

Contracts

TAYLOR WOODROW CONSTRUCTION, Ltd., has been awarded a contract worth about £350,000 by the Solartron Electronic Group, Ltd., for a five-storey office block and single-storey factory extension at Farnborough, Hants. This is the second stage of a four-stage, £1,250,000 expansion.

W. H. ALLEN, SONS AND CO., Ltd., has received an order from the Burmah Oil Company (Pipe Lines), Ltd., placed on behalf of Oil India (Private), Ltd., Calcutta, for diesel engines, dual fuel engines and diesel-driven generating sets for a crude oil pipe-line project in Northern India. The order is for fifty-one engines, thirty for pumping duties in nine stations, and twenty-one for electricity generation in seven stations.

A. AND J. INGLIS, Ltd., has received an order from British Transport Docks for a twin-screw diesel engine propelled triple-grab hopper dredger and a diesel-engined hopper barge, for use at Garston Docks. The dredger will have a length of 200ft by 45ft beam by 17ft 6in depth, a hopper capacity of 1700 cubic yards and a speed of 12 knots. The particulars of the barge are length 190ft, breadth 39ft, depth 14ft 6in, capacity 1200 cubic yards and speed 12 knots.

HOVERCRAFT DEVELOPMENT, Ltd., has placed a contract with Saunders-Roe, Ltd., of East Cowes, which will extend the use of Hovercraft SRN-1 as a research vehicle. Blackburn and General Aircraft, Ltd., has loaned a Turboméca "Marbore" turbine of 880 lb thrust, which will be mounted on SRN-1 to provide additional forward thrust. Work on the modification will be completed by the end of April. The additional thrust will provide valuable information about the behaviour of hovercraft at considerably increased speeds; trials will start in May.

Miscellanea

CANADIAN PACIFIC LINER.—The Canadian Pacific liner under construction at the Naval Yard, Walker, of Vickers-Armstrongs, Ltd., will be launched on May 10 by Mrs. J. G. Diefenbaker, the wife of the Canadian Prime Minister, and be named "Empress of Canada." The ship which is 650ft long by 86·6ft beam will carry 200 first and 860 tourist-class passengers at a service speed of 20 knots.

THIRD INTERNATIONAL CONGRESS OF THE PRECAST CONCRETE INDUSTRY.—The third international congress of the precast concrete industry is to be held in Stockholm on June 16–22 next. The congress will include an exhibition, technical sessions on three days, various social events, and visits to precast concrete works nearby. Further details may be had from the British Cast Concrete Federation, 105, Uxbridge Road, Ealing, W.5.

JOINTING MATERIALS.—A compressed asbestos jointing material for use at extremely high temperatures and pressures developed by Richard Klinger, Ltd., Sidcup, Kent, is made of "Hycar" nitrile rubber, a synthetic product of British Geon, Ltd. This jointing is known as "Klingeret 400 Universal," and is stated to be capable of withstanding pressures in excess of 22,000 lb per square inch and temperatures of 1500 deg. Fah., and over, without adverse effects. It is resistant to lubricants and fuels used in gas turbines and is suitable also for general gasketing applications in engineering plant.

SOUND DEADENING MATERIAL FOR SHEET METAL EQUIPMENT.—A material has been introduced by Supra Chemicals and Paints, Ltd., Hainge Road, Tividale, Tipton, Staffs, for "sound deadening" and to suppress drumming in equipment made of light gauge sheet metals. This material, known as "Dedshete" is supplied in flat sheet form and is self adhering. It is simply placed upon a fabrication and stoved at 300 deg. Fah. for five minutes, during which time it moulds itself and adheres to a contour. Adhesion of the material is unaffected by subsequent phosphating or similar prepainting treatments, hot water, detergents or dilute acids or alkalis.

CONTINENTAL AFFAIRS

by Our Continental Editor

Transport and Communications Museum

THE Swiss Institute of Transport Association (Verein "Verkehrshaus der Schweiz"—V.H.S.) was founded in Zurich on February 26, 1942, with the principal objective of bringing into existence a national museum covering all aspects of transport and communications. The Institute, moreover, was to assist in the spreading of knowledge in those fields by operating a public relations service dealing with general information as well as with selected topics such as, for instance, safety, or vocational guidance. Its range of activities was widened by the foundation in 1957 of the sub-section "Schweizerische Verkehrswissenschaftliche Gesellschaft" (Swiss Society for Transport and Communications Research) which is concerned with current scientific problems.

Although the earliest ideas for a transport museum appear to have been mooted as early as 1883, for many years nothing further was done beyond the collection, by various organisations, of historically interesting material, as had been suggested at the time of the railway jubilee in 1897, and the showing in public of some of these collections on the occasion of the national exhibitions of 1914, and also in 1939. However, a small museum was opened in 1918, in rather inadequate premises in the Zurich Goods Station.

The new museum, which was inaugurated last July after four years of preparation and construction, was established through the interest shown by the Swiss Federal Railways (S.B.B.), the private railway companies, the Post Office authorities, road transport associations, and the Federal Government, who between them contributed nearly Fr.5,000,000 for the first stage. The site at Lucerne-Brüelmoos was made available in 1956 by the Lucerne Council when it appeared that no suitable plot was available in Zurich. Although the subsoil of this 23,257 square metres area was poor, requiring extensive filling-in with hard core, and piled foundations for all buildings, the situation between the Gotthard Line and the lake shore is favourable, both from the point of view of transporting exhibits and for attracting visitors.

There are at present six main exhibition halls, aggregating some 10,000 square metres of floor space, grouped around a courtyard measuring 80m by 40m. All the main buildings are joined by connecting halls which form covered passages and offer additional space for the smaller exhibits. The structures are in either steel or concrete, with façades in brick or glass.

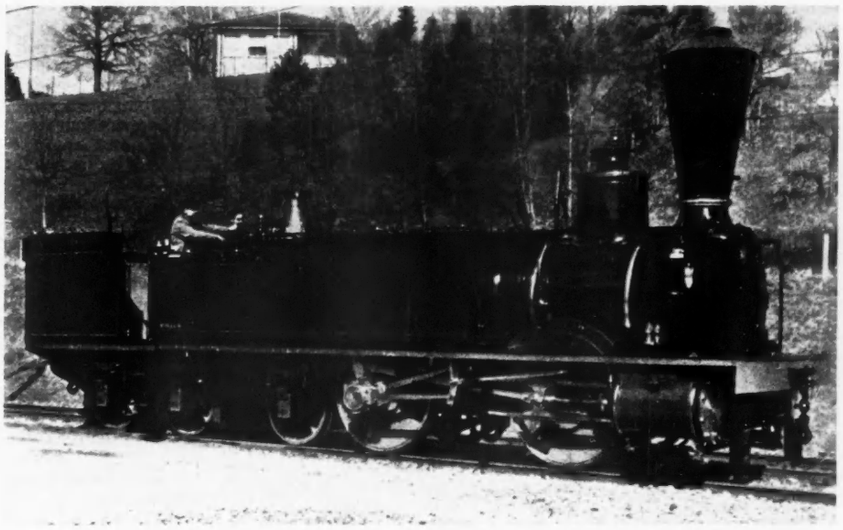


Fig. 2—Locomotive "Genf" of the Swiss Central Railway (1858). This engine which, like all others in the museum, is in full working order, has a cylinder output of 260 h.p. at 26km per hour; its maximum speed is 60km per hour, and its weight in running order, 46·7 metric tons

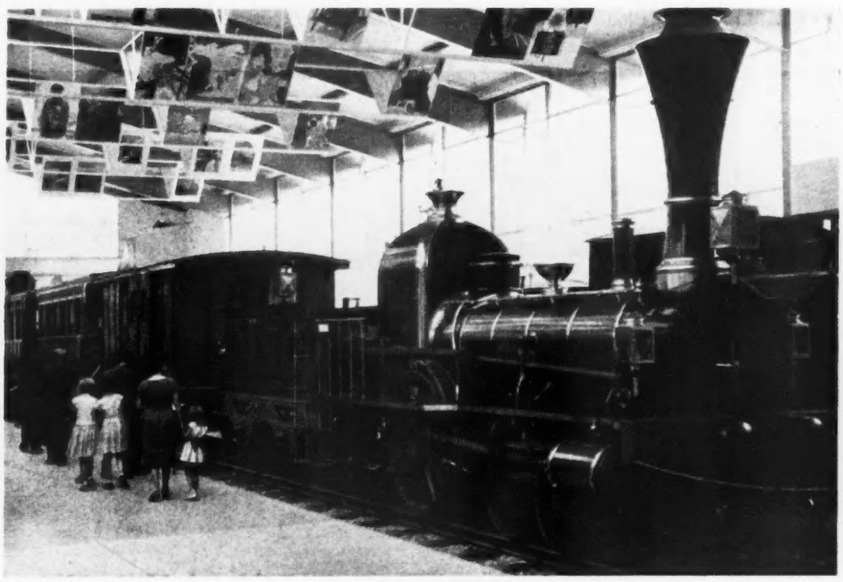


Fig. 1—Replica of train of the first Swiss railway, Zurich-Baden (1847), the so-called "Spanisch-Brotli-Bahn"

The entrance building contains a large entrance hall of 200 square metres, as well as the archives, library and offices. Proceeding in a clockwise direction round the central area, the visitor next comes to the railway section, which occupies a total floor space of some 3000 square metres and about 40 per cent of the total building volume. The principal hall measures 52m by 19m and is 9m high. The portal steel frame is cantilevered on the side away from the courtyard, to form a two-storey annexe with gallery. On three 40m to 45m long tracks on the main ground floor are exhibited various examples of rolling stock and engines, while others, through lack of covered space, have to be exhibited out of doors at the back of the building. The annexe and gallery contain sub-assemblies and models, the latter carried out uniformly to a scale of 1 : 10 full size.

The smaller railway hall measures 30m by 16m and is used for thematic presentations and temporary exhibitions. Its glass façade overlooks the lake, with the town of Lucerne in the background.

In the large connecting hall between these two buildings is housed, besides other exhibits, an extensive model, carried out to 1 : 90 full scale, of the Gotthard railway between Erstfeld and the Naxberg tunnel near Göschenen (northern ramp). This 12·5m long and 6m wide working model comprises over 300m of track and fifty points, including forty points at Erstfeld station which are push-button controlled from a diagrammatic panel. The rolling stock includes

CONTINENTAL AFFAIRS *(Continued)*

some thirty locomotives and 200 carriages and trucks.

All the historical engines at the museum are in working order and can be brought back into use for special occasions such as important railway anniversary celebrations. Besides a copy of the "Spanisch-Brötli-Bahn" train of 1847 with engine "Limmat" (Fig. 1), there is the original "Genf" engine which on April 27, 1858, opened the old Hauenstein line from Basle to Olten, and 100 years later pulled the centenary train (Fig. 2). This design, due to Engerth, was first developed for the Semmering railway; in Switzerland, 110 examples were used as express, goods and mixed service engines. Of the Mallet design of 1893, twenty-eight were employed on the old Hauenstein line. Mountain railways are represented by the first engine built by the Swiss Locomotive Works (S.L.M.) at Winterthur in 1873, to Riggenbach's design, for the Vitznau-Rigi railway (Fig. 3).

From the field of electric traction there are many examples of Swiss pioneering work, such as the three-phase locomotive of the Burgdorf-Thun railway of 1899 (Fig. 4). This 40km long line was operated with 40 c/s current at 750V, and is believed to be the first occasion on which three-phase current was used on a standard gauge railway. The favourable results obtained prompted the maker, Brown Boveri & Co., to install and operate at its own expense three-phase traction in the Simplon tunnel when this was opened in 1906. Also exhibited is the experimental Oerlikon locomotive No. 1 which was used between 1904 and 1909 on the 20km Seebach-Wettingen line (Fig. 5). Originally this locomotive was equipped with a rotary converter which changed the line voltage of 15kV, 50 c/s, single-phase, into direct current. Just before it was commissioned, Oerlikon succeeded in producing a suitable single-phase motor for 15 c/s. The No. 2 locomotive of 1905 was equipped with this motor, doing away with the converter. The No. 1 locomotive was changed over subsequently to the new system and was in use until 1958, while No. 2 is still used on occasions.

On the basis of this experience, as is well known, single-phase low-frequency traction was generally adopted in Switzerland. An early example preserved at the museum is the 2500 h.p. Lötschberg engine, of which thirteen were built. This was the most powerful locomotive of its day.

It is not possible within the present framework to give more than a brief outline of the museum's scope. Wisely, the temptation to overcrowd the available space has been firmly resisted. By concentrating on what is characteristic, it has been found possible to tell clearly the story of the main developments. It is intended to use the surplus material for frequently changing many of the exhibits.

Another large building is devoted to aeronautics, shipping and tourism. An important exhibit from the first of these fields is the biplane of the brothers A. and H. Dufaux (Fig. 6), which on August 28, 1910, for the first time flew the length of Lake Geneva. Another section is devoted to the achievements of E. Spelterini (1852–1931) who, between 1880 and 1926, made a large number of balloon ascents, including several flights across the Alps.

On the many lakes in Switzerland, waterborne traffic has been of great importance from immemorial times, and in the present century shipping on the Rhine, which had been eclipsed by the advent of the railways, has experienced a major come-back, owing to the improvements to the navigation in that river. These and similar developments are well illustrated by old paintings and prints as well as by models and original items. Among the latter must be mentioned Switzerland's oldest steamer, the "Rigi," built by Ditchborn and Mare, London, in 1847, which was in operation on Lake Lucerne until

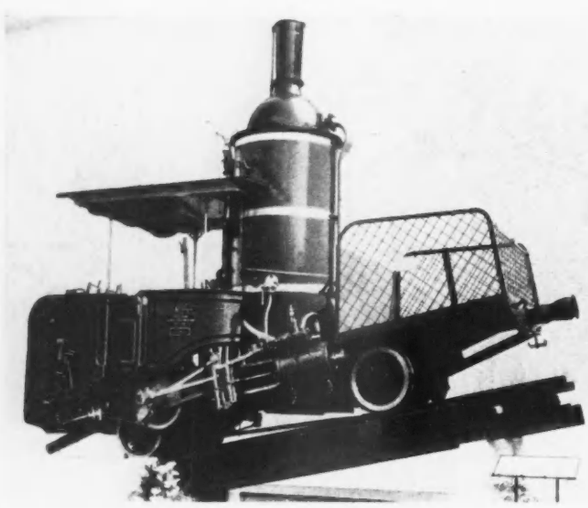


Fig. 3—Steam engine of the Rigi railway, 1873; this is the first engine built by the Schweizerische Lokomotivfabrik Winterthur (S.L.M.)

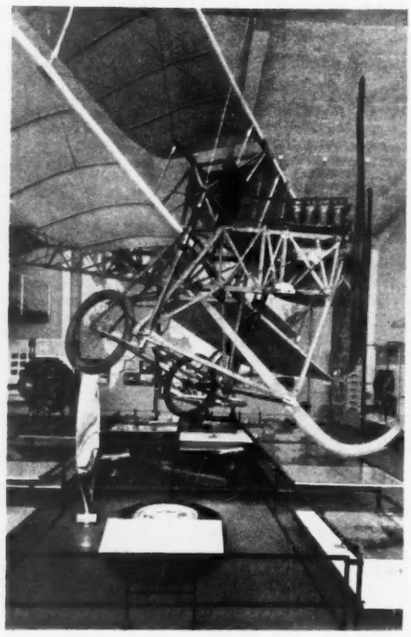
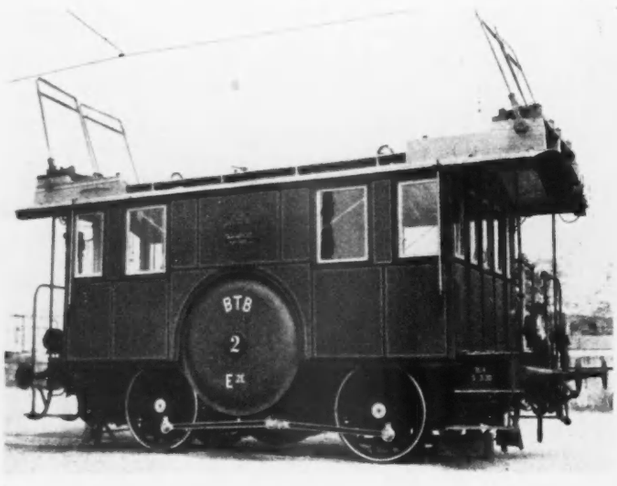
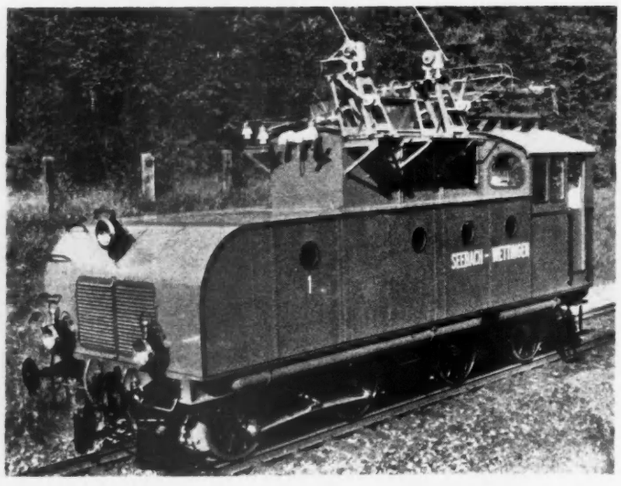


Fig. 6—On August 28, 1910, the biplane of the brothers A. and H. Dufaux flew for the first time the length of Lake Geneva east to west, taking 56 min 5 sec. The machine weighs 345 kg and is powered by a water-cooled, 50 h.p. engine





Figs. 4 and 5—(Left) Locomotive for three-phase current at 750V, 40 c/s, of the Burgdorf-Thun Railway (1899). Output of traction motors, 300 h.p. at 36km per hour; maximum speed, 50km per hour; weight in running order, 30 metric tons. (Right) First of two experimental locomotives for single-phase current of 15,000V, 15 (originally 50) c/s, built in 1904 for the Seebach-Wettingen line. Output of traction motors, 400 h.p. at 40km per hour; maximum speed, 60km per hour; weight in running order, 40 metric tons

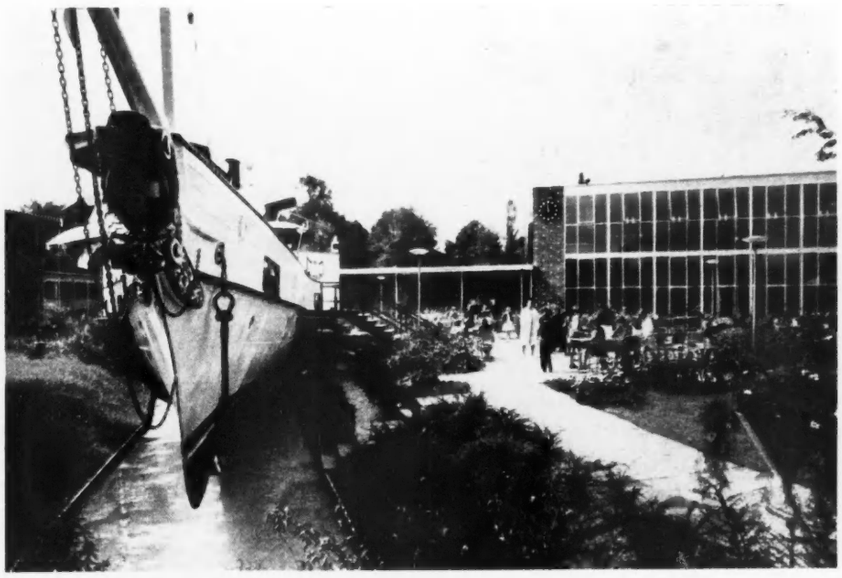


Fig. 7—Central garden courtyard with entrance building and S.S. "Rigi," the oldest steamer in Switzerland. Built in London by Ditchbourn and Mare in 1847, the "Rigi" was in service on the Lake of Lucerne for 105 years

1952. With the wooden superstructure restored to the original design, the 90-ton vessel now stands in the courtyard of the museum (Fig. 7). While the machinery and navigational equipment can be used for demonstrations, the main part of the top deck is employed as a restaurant. The "Rigi" which has a length of 138ft, a beam of 27ft, and could carry 200 persons, was moved from London to Strasbourg under her own power, from there to Basle by rail and from Basle to Lucerne by road. On her maiden voyage from Lucerne to Flüelen on April 1, 1848, she achieved a speed of 12 knots, and during 105 years of activity carried more than 6,000,000 people and travelled 675,300 nautical miles. It may be recalled that soon after 1847 shipbuilding became an important industry in Switzerland, where orders for many parts of Europe and overseas were carried out until the growing size of the vessels made it impossible to transport them overland and uneconomical to manufacture sections for assembly elsewhere.

In addition to the halls described, accommodation includes a large conference hall as well as two further halls devoted, respectively, to road transport and to telecommunications. In the former, besides such historic exhibits as the last horse-drawn post-chaise which, until the inauguration of the Gotthard railway in 1882, travelled between Flüelen and Camerlata near Milan, there may be seen the first Saurer lorry of 1903 and the 1904 Dufaux racing car which the following year set up the official world record with 96 m.p.h. Much space in the telecommunications pavilion is devoted to the development of the telephone system in Switzerland, including a large diagrammatic panel of the local and international network and such relics of the past as manually-operated exchanges.

Blasting of Earth-Covered Rock

In the excavation of the Lindö Canal which is at present being carried out, a novel method of blasting is being employed which allows rock to be blasted without first removing top layers of moraine, clay or earth. The canal will form a new outlet from the harbour of Norrköping on the east coast of Central Sweden. If the bedrock were first exposed, by removing the overburden in the conventional manner, there would be a danger of the surrounding slopes of wet clay caving in. With the new method it is stated that a firm mixture of rock debris and surface material is obtained which can safely be removed by a power shovel.

The contractors, Skånska Cementgjuteriet, have evolved the system over the last ten years in co-operation with Atlas Copco, the Sandvik Steelworks, and Nitroglycerin A.B. It is based on the Atlas Copco compressed-air method with series detonation, but uses a rock-steel surrounded by a steel tube equipped with a circular crown bit. The steel projects about 1in from the tube and works in conjunction with the latter until a depth of about 4in is reached in the rock. The tube is then disconnected from the drill, and remains stationary while drilling into the rock continues by means of the rock-steel only. When the central bit is withdrawn, the tube maintains a free passage between the surface and the rock. However, in order to preserve the tube, it is replaced by one of plastic through which the charge is inserted by means of compressed air. This use of compressed air for charging is claimed to save a considerable amount of time.

The rock profile at the bottom of the projected canal is very uneven, some peaks protruding almost to the surface while other parts lie much farther down. This has presented various problems both in connection with the drilling and in calculating the amounts of explosive required. Recently there took place the firing of what, until now, has been the largest single blast, using 56 tons of dynamite in the form of 4750 separate charges.

The completed canal will be 6km long and 10m deep, and will largely replace the present winding and difficult channel which, on account of its insufficient depth, limits the size of ships which can reach Norrköping and the building capacity of the shipyards there.

Soviet Power Development

In the Soviet Seven Year Plan for 1959–65,* provision has been made for the construction of forty power stations ranging from 500MW to 2400MW. As elsewhere, the trend is towards bigger stations, and the main stress will continue to be laid on thermal plant running on cheap coal, natural gas, and fuel oil. While in the 1951–55 period the capacity of individual stations did not exceed 400MW, and more recently reached 600MW, these figures will be substantially exceeded. The Troitskaya power station (Urals) and Starobeshevskaya state regional power station (Donets Basin), both under construction, will have 1500MW each, while Tom-Usinskaya (Siberia) will have an installed capacity of 2000MW. A number of 2400MW plants are projected; these will be of the same order of size as the largest hydro-electric stations on the Volga. Output of electricity in the next seven years is to be increased by 110–120 per cent.

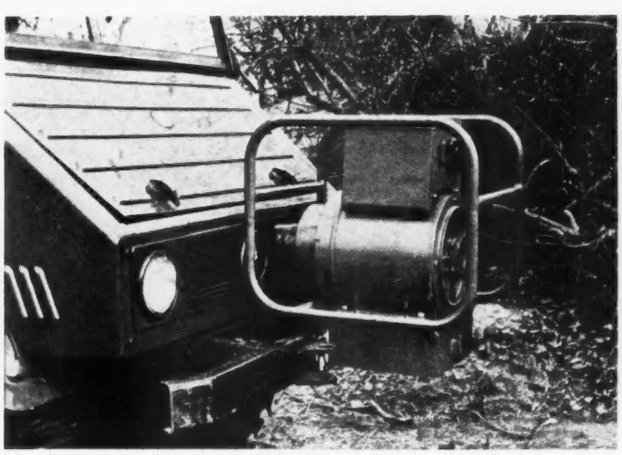
It is expected that the Baltic Regional thermal power station will come into service in the autumn. This station will supply not only Estonian towns and villages but also the Latvian capital, Riga, and a projected industrial centre at Narva, near Leningrad. The Baltic station will become the biggest power station in this part of the Soviet Union. It will operate on fuel from big local shale deposits, and comprise a number of 100MW turbo-generator sets each with its own 220 tons per hour boiler. Steam conditions are reported as 100 atmospheres and 540 deg. Cent.

Metal Cutting Circular Saw

An improved version has been put on the market of the "Barson" metal cutting circular sawing machine, made by Wandsbeker Werkzeug-Gesellschaft Beinhoff and Co., Hamburg-Wandsbek, Königsreihe 14-16. The "Barson-Rotor," equipped with a swivel-mounted sawing head which can be set in a simple manner at any angle between 45 deg. to the left and 30 deg. to the right of the plane intersecting the axis of the workpiece at right angles. This in most cases avoids the necessity of moving the workpiece for carrying out mitre-cuts, an advantage which is particularly valuable when cutting long materials in a small and congested workshop. High speed steel saw blades of 275mm diameter are employed. Up to 90mm by 90mm or 40mm by 150mm bar material, 90mm diameter tubes, and 60mm diameter solid round bars can be cut. The machine can be supplied equipped with coolant pump, and is fitted with either a three-phase or a single-phase a.c. motor, or with a pole-changing motor for obtaining two cutting speeds.

High-Frequency Portable Generator

For use with the four-wheel drive, cross-country pick-up lorry "Unimog," the firm of Robert Bosch G.m.b.H., Stuttgart, has put on the market a portable generator which enables the vehicle to be employed as a small power plant for high-frequency electric road drills, grinders, chain saws and other equipment, as well as for welding, heating and lighting.



Portable 7kVA, 200 c/s, generator connected to power take-off of "Unimog" lorry

The generator is connected by a spline to the front power take-off and clamped to the bumper by means of a hook-ended, threaded bar and nut, as shown in our illustration. Rated output is 7kVA, three-phase at 265V, 200 c/s, or up to 4kVA, single-phase, at 220V, 200 c/s. The generator operates at 3000 r.p.m. and is driven from the 520 r.p.m. power take-off through a chain transmission. It weighs approximately 109 kg.

* THE ENGINEER, January 16, 1959 page 118

THE AMERICAN SCENE

by Our American Editor

Progress of the Tennessee Valley Authority

No. III—(*Concluded from page 668, April 15*)

Water Control Operations

BECAUSE of favourable rainfall and run-off conditions in the last half of the previous year, the reservoirs at the beginning of the 1959 fiscal year had 8,040,000 acre-feet of water in storage. Of the total, 85 per cent was in the tributary reservoirs and the three mainstream reservoirs above Chattanooga. The 1959 rainfall and run-off, however, were both below average generally. Above normal rainfall occurred in the six months of July, September, November, January, April and May, but less than normal in the remaining six months. Deficiencies were greater than excesses, however. As a result, the rainfall over the Valley averaged 47·1in, as compared with the long-time average of 51·5in and as compared with 54·9in in the previous year. In the first six months of the year the use of stored water for hydro-electric production during the autumn–early winter drawdown brought most of the reservoirs to points substantially below the required flood control levels at the beginning of January. These releases also aided in maintaining navigation depths in the lower Ohio and Mississippi rivers. Filling of the reservoirs began in mid-January, with the heaviest storage occurring in April as a result of above average rainfall and run-off for the month. Because of the generally deficient run-off during the last half of the fiscal year, however, filling was below average. As a result, the useful water in storage at the end of the fiscal year was 7,230,000 acre-feet, 810,000 acre-feet less than at the beginning. Water stored in reservoirs upstream from Chattanooga made up 84 per cent of the volume.

Crests of three floods on the lower Ohio and Mississippi rivers, one in late July and early August, 1958, and two in February, 1959, were lowered by the operation of the T.V.A. reservoirs. Reductions ranged from 1·7ft to 2·7ft at Paducah, Kentucky, and from 1·0ft to 2·2ft at Cairo, Illinois. However, the amount of damage prevented was small, amounting to only 50,000 dollars in the February floods. Thus, the total estimated damage prevented on the lower Ohio and Mississippi rivers was increased only slightly, to a cumulative total of 20,151,000 dollars. The estimate for Chattanooga, the most vulnerable city on the Tennessee, remained at 120,213,000 dollars since no flood threat occurred.

The first flood period of the fiscal year extended from July 22 to August 11, 1958. Water was spilled from the T.V.A. system in advance of the crest on the Ohio, and then discharge at Kentucky Dam was gradually reduced to zero. For two days the flow of the Tennessee was bottled up in the Kentucky reservoir and others in the T.V.A. system in order to obtain the maximum reduction at Cairo. It was the first time during flood control operations that all discharge had been cut off. It brought about a reduction of 1ft at Cairo at the time of the crest on July 27. During the flood period, the Pickwick Landing reservoir was filled to near the top of the spillway gates in order to limit the rise in the Kentucky reservoir, and thus avoid flooding areas which are dewatered during the summer months as a malaria control measure.

A report entitled "A Programme for Reducing the National Flood Damage Potential," based on T.V.A. experience in assisting communities to assess and meet their local flood problems, was prepared during the past year and was submitted to the Congress. It is believed that if the plan suggested in the report is adopted, it could reverse the present trend toward increased flood damage potential and greater demands on the U.S. Federal Government for flood control works. The report recognises the two basic approaches to the problem of flood damage prevention: (1) to control the extent of flooding by construction and operation of dams and reservoirs, levees, and other protective works; and (2) to reduce potential damages by using flood plain lands only for purposes which take account of the flood hazards. It suggests that more emphasis should be placed on the second approach—flood damage avoidance—pointing out that local communities have a responsibility for guiding their own growth so that future developments will be kept out of the path of flood waters.

The plan is based on six years of practical experience in initiating and co-operating in such a programme. In the Tennessee Valley there are about 100 communities with local flood problems of varying degrees which are outside the protection of the T.V.A. flood control system. Most of the communities are upstream from the T.V.A. dams and reservoirs or on smaller streams. More than seventy communities, acting through their State planning agencies, have requested assistance from T.V.A. in meeting their local flood problems. In response, T.V.A. has prepared forty-seven reports outlining the flood situations in fifty-two communities.

The report contains maps and profiles of large floods that have occurred in the past and those which might reasonably be expected in the future. They define the areas which would be inundated, speed of flow, swiftness of rise, and other factors. In preparing such reports, the Authority uses flood data which it has already assembled in planning and operating its system of reservoirs, supplementing the information where necessary with field investigations. The reports do not recommend plans for solving the local flood problems. Rather they provide a basis for further study and planning by the community itself. State planning agencies work closely with T.V.A. in the programme and assume responsibility for providing technical assistance in zoning, building standards, borough regulation and other devices by which communities guide and limit development on flood plains. T.V.A. also provides technical and engineering assistance to the State and local groups.

The plan, essentially, provides a channel through which valuable flood information in the working files of these Federal and State agencies can be made available, together with expert technical advice, to communities which want and need to use it. In fiscal year 1959, eleven local reports were completed, and present plans call for completing about ten each year. More than half the reports completed to date have been put to good use in keeping private homes, schools, business establishments, and industries out of flood hazard areas. Eighteen communities are making supplemental planning studies to develop flood plain regulations and nine have adopted such regulations. Three communities have developed plans for flood protection in conjunction with urban renewal projects.

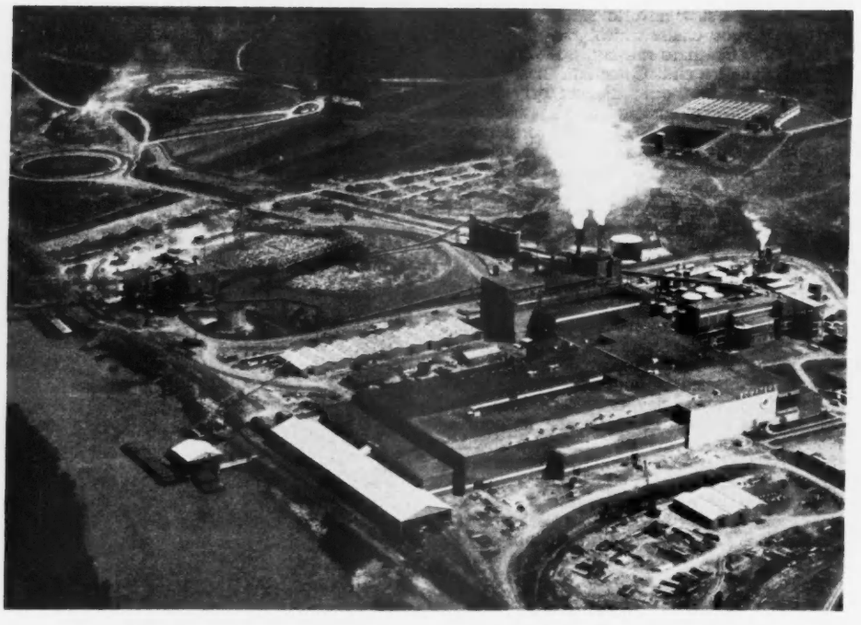


Fig. 11—Expanded works of the Bowaters Southern Paper Corporation on the Chickamauga reservoir in Tennessee

River Navigation

Shippers using the Tennessee waterway in the calendar year 1958 saved 24,000,000 dollars over the next cheapest available mode of transportation. In computing these savings the shippers' costs in using a route involving barge transportation are compared to the costs which would have been borne if the navigation channel had not been built. The estimated savings were 2,500,000 dollars above those of 1957, the previous record year. The savings exceeded the total costs of maintaining and operating the waterway, including depreciation, by 19,700,000 dollars, an amount equal to a return of 14½ per cent on the net navigation investment of a little over 136 million dollars. The total navigation investment, before depreciation, was 158,500,000 dollars. The cumulative savings through the use of the waterway amount to 161 million dollars, while the cumulative Federal costs of operation and maintenance have been less than 63,000,000 dollars. About 12,000,000 tons of freight moved on the waterway, a decline of 5 per cent from 1957. Coal shipments, mainly to T.V.A. steam power stations, were down 1,500,000 tons, but this was partially offset by increases in the movements of other commodities.

The growing value of the waterway is indicated by the appearance of new commodities in shipments during the year and by industrial construction and expansion in waterfront areas along the chain of reservoirs. New movements included chemicals to Decatur, salt to Muscle Shoals, and manganese ore to Knoxville, while the first shipment of aluminium pig since 1954 was despatched from Knoxville. Regular movements of iron and steel from the Pittsburgh area to the south-east through the port of Guntersville were commenced by a company which assembles less-than-barge-load orders into barge-load lots.

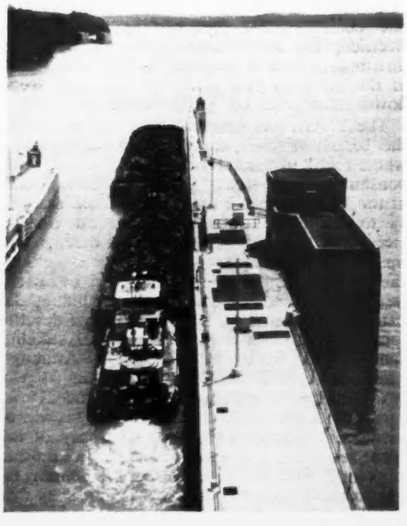


Fig. 12—A tow carrying pulpwood leaving the lock at the Chickamauga dam bound for the Bowaters works

Two barges, built at the Decatur shipyards for the Argentine Government, were despatched via the waterway.

The construction of a number of new works was begun by private firms at points of industrial development along the waterway. Among them were two chemical plants at Calvert, Kentucky, one near Huntsville, Alabama, and another near New Johnsonville, Tennessee. The fast-growing poultry and livestock industry in the south-east has made Guntersville, Alabama, the southernmost port on the waterway, an important centre for processing and selling midwestern grain delivered by barge. Here the expansion of one of four large grain terminals was commenced during the year. Construction also was started on a soya bean oil extraction plant.

Expansions were started during the year at several plants, and a large industrial firm began construction of a river terminal to serve its plants at Calvert City. The commencement of construction of a large paper and pulp mill at Counce, Tennessee, just downstream from Pickwick Landing Dam, led the Hardin County Port Authority to consider plans for a new river terminal for the receipt of pulpwood and shipment of paper. Since 1933 private industry has invested some 800 million dollars in 135 waterfront plants and terminals along the Tennessee. Nearly 90 per cent of the investment was made in the past seven years.

Power Generation

The use of electricity for general household, farm, business and industrial purposes continued to climb during the 1959 fiscal year, although at a somewhat reduced rate because of the general business recession. However, in the overall T.V.A. power operations, the growth in normal load was somewhat obscured as a result of the reduced use by Federal agencies and the smaller requirements of the city of Memphis. Excluding the Federal and Memphis loads, the consumption of electric power in the region increased by about 9 per cent in the fiscal year 1959. This compares with an increase of about 7 per cent in the whole country and the average annual increase of 12 per cent in the region. The T.V.A. power operations were affected by several factors : a severe drought heavily reduced hydro-electric generation and resulted in greater reliance on more expensive fuel-generated power. The business recession slowed the growth of industrial power use until late in the year. A winter less severe than in the previous year reduced the use of electricity for house heating and resulted in a less-than-average increase in domestic consumption. The Atomic Energy Commission further reduced its short-term purchases of power, more than offsetting some increased use by other Federal agencies. The city of Memphis obtained less power from T.V.A. and supplied more of its requirements from its own steam power station. The use of power by industrial plants served directly by T.V.A., particularly aluminium producers, showed a substantial increase. On balance, these factors resulted in an increase in total sales from the T.V.A. system and increases in total operating revenues and revenues from the sale of power. However, due chiefly to adverse hydro-electric conditions, operating expenses increased more rapidly than revenues and the net operating income was less than in either 1957 or 1958.

Despite a reduction of nearly a thousand million kilowatt-hours in the deliveries to the A.E.C. plants at Oak Ridge, Tennessee, and Paducah, Kentucky, the Federal Government continued to be by far T.V.A.'s largest customer. Sales to Federal agencies amounted to practically 50 per cent of all power sold. During and after the Korean war, the A.E.C. purchased considerable additional amounts of power on short-term agreements in order to increase its production. In recent years, A.E.C. production has reverted to normal levels and the demand for supplemental power has been correspondingly reduced. However, should national defence considerations require it, the A.E.C. might at any time need increased deliveries up to several hundred thousand kilowatts.

The next largest block of power, more than 30 per cent of total sales, went to the municipal and co-operative systems which serve nearly 1,400,000 ultimate consumers. The increase of about 6 per cent in both power use and revenues was less than normal because of a reduction in consumption for house heating and a less than average increase in industrial and commercial use. If heating loads are adjusted in both 1958 and 1959 to reflect median temperatures, the growth in loads of the municipalities and co-operatives in 1959 would be about 8 per cent ; the difference between this figure and the typical recent growth of 12 per cent indicates the effect of the general business recession. A substantial recovery in industrial demands was in evidence at the close of the year, but was too late to have more than a moderate effect. The recession also reduced industrial loads served directly by T.V.A., but this was offset by a new aluminium reduction plant which went into operation.

The total system input amounted to 62,600 million kilowatt-hours, of which 61,000 million kilowatt-hours was generated and 1600 million kilowatt-hours was obtained, mostly on an interchange basis, from other systems. The total generation was about the same as the year before, but there were significant shifts in the sources of the power generated. Because of the drought, the worst in the Tennessee Valley for any full fiscal year since 1942, hydro-electric generation accounted for less than 25 per cent of the total. The effect of the drought was more noticeable because it followed extremely good water conditions in the previous fiscal year. This year the run-off from the watershed above Chattanooga, the mountain and ridge-and-valley section where the major storage reservoirs are located, was above average for only two months out of the twelve.

A record net system peak demand of 9,702,000kW was established on January 6, 1959, during the hour ending at 8 a.m. The demands of the various classes of customers at the time of the peak were estimated as follows :

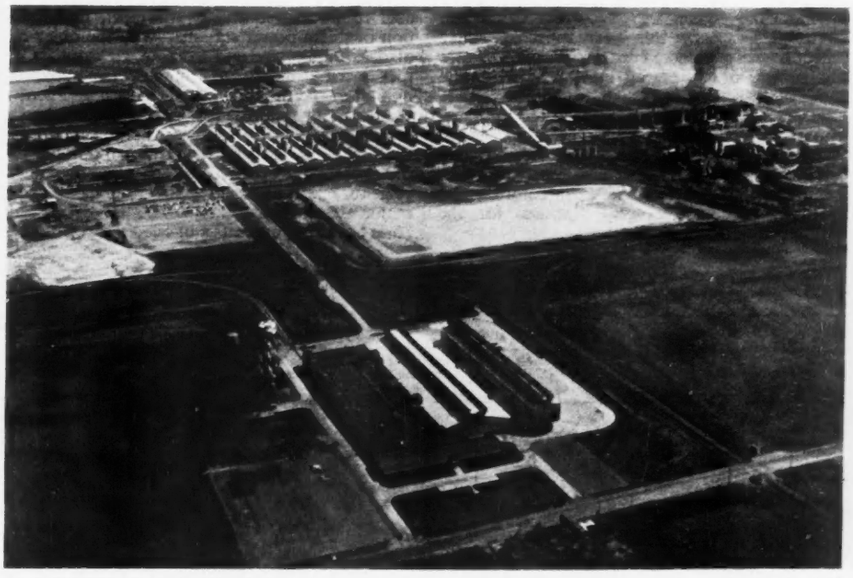


Fig. 13—New aluminium reduction plant of the Reynolds Metals Company in Alabama, designed to supply liquid metal to the Ford aluminium foundry in foreground

THE AMERICAN SCENE *(Continued)*

municipalities, co-operatives, and system losses, 5,102,000kW ; direct commercial and industrial service, 1,346,000kW ; and Federal agencies, 3,254,000kW. The municipal and co-operative demand included all the requirements of Memphis, since its new steam plant was temporarily out of service. Because of the generally low levels of reservoir storage and more than normal outages of units at the steam power stations, about 566,000kW at the time of maximum demand were obtained from other systems, which had ample margins of capacity above their own loads. With these receipts from others it was unnecessary to place in operation the older steam plants of the Authority.

The steam power stations established a new record low system heat rate averaging 9660 B.Th.U. for each net kilowatt-hour generated. Compared with 1958, the cost of coal received and the cost of coal burned declined by 1·8 per cent and 1·6 per cent, respectively ; however, at the end of the year coal costs had begun to rise again after a two-year decline. The decline was due in part to the business recession and in part to decreasing coal purchases by T.V.A. during the two years. By midyear both of these influences on coal costs had disappeared. In addition, minimum wage rates for bituminous coal miners were increased by the Secretary of Labour under the Walsh-Healey Act, and the United Mine Workers negotiated somewhat higher wages that took effect during the last half of the year. The cost of coal purchased during the year averaged 4·42 dollars per ton and 18·59 cents per 1,000,000 B.Th.U.

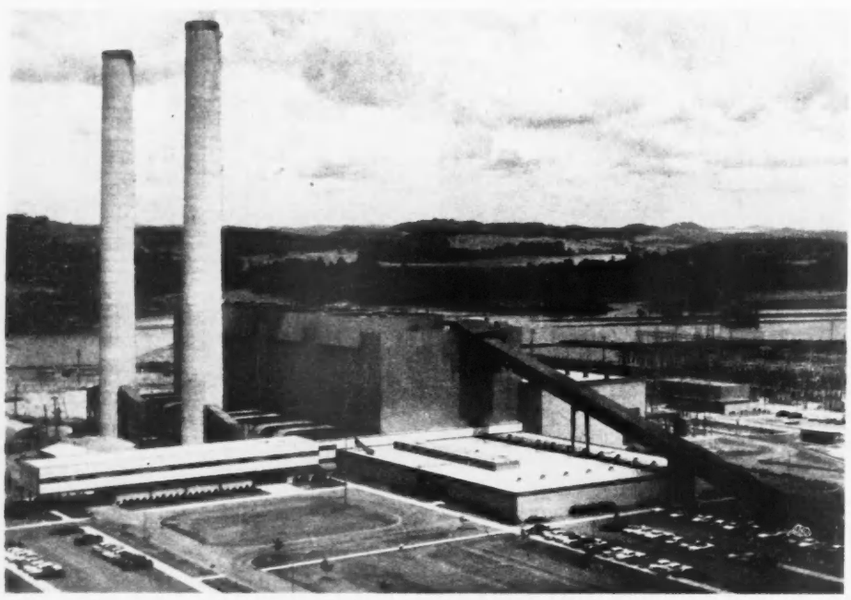


Fig. 14—John Sevier steam power station in Tennessee—the most efficient T.V.A. plant with a heat rate of 9390 B.Th.U. per kilowatt-hour

The previous record was 9705 B.Th.U. in 1957 ; in 1958 the figure was 9760 B.Th.U. The increased efficiency this year reflected better scheduling of available capacity, including more regular use of generating units that were idle some of the time in 1958 due to good hydro-electric conditions ; it also reflected progress in correcting some of the difficulties experienced with a number of new units. The steam power stations consumed 18,600,000 tons of coal, 9·5 per cent more than the year before. The following table shows coal statistics for the major power stations :

Continued study was given to all phases of coal resources—contracts, transport, and location of steam power stations—with the objective of assuring steady and economical supplies of fuel in the years ahead. Studies of the costs of mining in the major supply areas led late in the year to an invitation to bid on long-term contracts for providing coal. This was the first long-term bid invitation since 1957. The invitation sought bids to supply up to 3,000,000 tons of coal a year for existing steam generating facilities at major steam plants except Widows Creek and John Sevier, in quantities of 5000 tons or more a week for terms of five to twenty years, and an opportunity to offer additional quantities for later deliveries to supply generating units which T.V.A. might build after the enactment of revenue bond financing legislation.

Coal Statistics for Major T.V.A. Power Stations

Power station	Coal received		Coal burned		
	Thousands of tons	Cents per million B.Th.U.	Thousands of tons	Cents per million B.Th.U.	B.Th.U. per net kWh
Shawnee	4,715	16·56	4,835	16·69	9,720
Colbert	1,420	19·58	2,255	19·59	9,460
Gallatin	1,535	18·87	1,442	18·90	9,420
Johnsonville	2,425	18·19	2,695	18·24	10,060
John Sevier	1,393	20·04	1,503	20·27	9,390
Kingston	3,943	19·69	4,334	19·79	9,620
Widows Creek	1,150	19·90	1,576	20·22	9,790
Average or total	16,581	18·59	18,640	18·80	9,660

A five-year extension of a contract with the Badgett Terminal Corporation, of Grand Rivers, Kentucky, for the transfer of coal from rail to barge was negotiated at charges about 1 cent a ton or 5 per cent more than those now in effect. The major portion of the coal for the Johnsonville and Colbert steam power stations passes through this terminal. Further efforts were made to take advantage of the very deep navigation channel between Grand Rivers and Johnsonville. This reach of 75 miles in the lower part of the Kentucky Dam reservoir offers the opportunity of lowering coal transport costs through the use of very large barges. Bids were asked on a sliding scale for the movement of 2,000,000 to 4,000,000 tons of coal annually for a term up to eight years. A number of bids were received for moving coal with special equipment at substantial savings.

In implementing the provision in the T.V.A. Act directing the Authority to encourage the widespread and abundant use of electricity, power is distributed to the homes, farms, businesses, and most of the industries of the region by 153 local electric systems. These include ninety-nine municipal systems, fifty-one rural electric co-operatives, two small private electric utilities, and A.E.C. operations in the city of Oak Ridge. The local systems sold more than 16,600 million kilowatt-hours to 1,380,600 customers during the year. Their operations were affected by the business recession, which slowed the rate of commercial and industrial use of power, and by a winter less severe than the one before, which reduced the demand for electricity for house heating. Nevertheless, the distributors sold 6 per cent more energy than in the previous year and their revenues from power sales increased by 5 per cent.

The T.V.A. Act stresses the use of power for the benefit of the people of the section as a whole and " particularly the domestic and rural consumers," and seeks " domestic and rural use at the lowest possible rates and in such manner as to encourage domestic and rural use of electricity." This is being achieved through the operations of the distributors. Not only does the emphasis on domestic and rural use carry out the purposes of the Act in extending the benefits of electricity, but it also provides the local systems with a greater financial stability than is enjoyed by most systems. Although residential electric sales vary from year to year with changes in climate, neither in the T.V.A. area nor in the whole country did the growth of residential sales falter materially in any of the three recessions that have occurred since the end of World War II. The average residential use of electricity by customers of the local electric systems was 7863kWh for the year, as compared with 7654kWh the year before. The average cost for residential service was 1·03 cents per kilowatt-hour. In the United States the average domestic customer used 3450kWh at a cost of 2·52 cents per kilowatt-hour.

An average residential consumption of more than 10,000kWh per customer was reported by twenty of the municipal systems, among them the three largest cities—Chattanooga, Nashville, and Knoxville. Chattanooga, serving an average of 73,000 residential customers, reported average use of 12,250kWh, higher than for any other system of comparable size in the United States. A strong trend towards the all-electric home continued ; four out of five new homes are electrically-heated. It is estimated that 250,000 homes in the area, or nearly 20 per cent of the total, are heated entirely with electricity. On the average, the electrically-heated home in the region used about 21,000kWh of electricity a year; the average for those not using electricity for heating is about 4400kWh a year. The difference, however, is not accounted for by

heating alone. It is due to the fact that the electrically-heated home is likely to use electricity also for all important home appliances, including kitchen stoves, and waterheaters as well as refrigeration.

Four distributors—a co-operative, and three municipal systems—adopted rates about 10 per cent below the basic level during the year. Savings to consumers were also provided by nine other systems which removed a 10 per cent surcharge formerly applied to the bills of their non-residential consumers. At the end of the year, virtually half of the distributors—seventy-four out of 153, including one privately-owned system—were applying rates below the basic level established in 1933. Of these, forty-six were charging rates about 10 per cent below the original rates and twenty-eight were applying rates about 20 per cent below. Most of the rate reductions have been made during the past decade, a period of rising costs when many utilities have been raising rates. The Federal Power Commission, in a recent report of typical electric bills, noted that for the country as a whole average residential bills have been showing "a continuation of the slight upward trend evidenced in recent years."

Research and demonstration activities, supplementing the inducement of low rates in bringing about increased use of electricity and consequent reductions in the unit costs of service, were aimed particularly at a more effective use of electricity on the farm. Near the end of the year, interest was being centred on the use of electricity in handling farm products and materials with a minimum time and maximum efficiency. Plans were made to assist test-demonstration farmers to set up completely modern materials-handling methods, bringing farming operations as near to production-line methods as possible. Farm materials-handling workshops were set up for vocational agriculture teachers in co-operation with State departments of education, power distributors and appliance and equipment manufacturers.

Electric equipment on trailers were used to show how grains and feeds can be brought from the field, dried, processed and delivered to the feed trough without manual labour. Materials-handling installations in dairy farming, poultry raising and livestock farming are bringing significant changes on some farms. For example, on a Kentucky farm, two persons now feed and milk seventy cows in an hour and a half with electric equipment. An Alabama poultry man saves 175 dollars a week in feed costs by using electricity to grind and mix feed for his laying flock of 10,000 ; he also uses electricity to inspect, grade and wash eggs. More than 400 vocational agriculture teachers attended workshops covering farmstead lighting, including actual design and installation of such systems. A farm water system programme continued with growing success. It is carried on as a co-operative effort by T.V.A., the distributors, State and county health agencies, and dealers and manufacturers of farm water systems equipment. In a period of five years, the proportion of farms having such systems has grown from less than one-quarter to more than one-half. In the research field, agricultural engineers of the Authority completed designs for a device to warm drinking water for poultry, an electrically heated plastic greenhouse and a sweet potato curing house, and farmers have begun using them. A Mississippi farmer who used the sweet potato curing house design reported a profit from it of about 1600 dollars.

Fertiliser Development

Farmers throughout the United States for years have bought their fertiliser by the bag and wrestled it laboriously from warehouse to lorry to barn to hopper to field. In recent years farmers and the fertiliser industry have been watching something new on the horizon and viewing its rise in popularity with cautious optimism. They hope that in this new product science will have brought forth a new means of lightening the labour of putting their plant nutrients on the land. This hope is the outgrowth of new developments in the field of liquid fertilisers. Many difficulties remain to be surmounted. High plant nutrient content, for example, is not as easily achieved in liquid as in solid fertiliser. But the challenge of these frontiers was the occupation of many scientists and engineers at the Muscle Shoals Fertiliser-Munitions Development Centre of the T.V.A. in the 1959 fiscal year. A pilot plant demonstration of fertiliser technology held at the Centre featured a special presentation in the field of liquids. Nearly 400 persons attended, coming from industries, universities and governmental organisations in thirty-six States and several foreign countries.

Liquid fertiliser mixes were first used in California and in the past six or seven years have become popular in other parts of the country. It is estimated that about 300 plants are in operation, compared to 167 two years ago, but the total output is still relatively small. Liquid mixes amount to 5 per cent or less of the total U.S. mixed fertiliser production. T.V.A.'s work, started four years ago with a thorough survey of the industry, seeks to overcome two major problems : (1) the limited solubility of the raw materials generally used, which prevents production of high analysis and varied grades such as are produced in solid fertilisers, and (2) the high cost of raw materials.

Phosphoric acid is the source of P_2O_5 in practically all liquid fertiliser production and is a relatively high-cost source of phosphate compared with that used in most solid fertilisers. The development of superphosphoric acid by T.V.A., with its unusual properties, is one of the most important and versatile advancements in fertiliser technology to emerge from the Muscle Shoals Centre in recent years. Its high concentration—76 per cent P_2O_5 as compared with 54 per cent for regular acid—promises considerable savings in handling and shipping costs. Engineers believe that it will furnish a key in the "break through" to higher analysis liquid fertilisers—and improved solid fertilisers as well—just as the T.V.A. ammoniator-granulator brought revolutionary advancement in the trend to the economical production of granular high-analysis solid mixtures several years ago.

The new superphosphoric acid has proved to be an excellent raw material for producing high-analysis liquids. Combined with nitrogen and potassium materials, super acid provides the basic material for making products containing ten to fifteen more units of plant nutrient than liquids made from ordinary electric furnace acid. Several highly concentrated liquid base solutions were made in pilot plant operations and in the demonstration plant. The major liquid fertiliser produced was ammoniated superphosphoric acid, an 11–33–0 base solution (11 per cent nitrogen ; 33 per cent P_2O_5 ; no potash). The material does not crystallise even at freezing point. The highest comparable grade made by private industry is 8–24–0. In addition to being used alone, the T.V.A. material was found to be valuable as an addition to wet-process acids to sequester impurities and produce clear liquids.

Liquid fertiliser developments have been carried far enough at Muscle Shoals for industry to try them in commercial plants, and co-operative assistance has been given to producers and dealers in connection with their problems. Four applications have been made for patents covering liquid fertiliser developments, and twenty-four royalty-free licences to use two processes have been granted to industrial concerns ; fourteen were on the process for producing high-analysis liquids from super acid and ten on the process using super acid with wet-process acid in making stable liquid fertilisers. T.V.A., as the sole supplier of the super acid in this country at present, has distributed nearly 2500 tons to manufacturers in order to encourage its production and use in manufacture of improved fertilisers.

The Central Farmers Fertiliser Company, of Chicago, began operation of a new electric furnace phosphorus plant at Georgetown, Idaho, in June ; the company relied heavily on T.V.A. for technical information and, at its request, production engineers from Muscle Shoals were on hand at the start-up of the plant. The plant produces phosphoric acid of slightly less concentration than T.V.A. super acid and is using it in the manufacture of concentrated superphosphate of 52 per cent P_2O_5 grade. The Electric Reduction Company, Ltd., of Toronto, whose engineers investigated the T.V.A. process, is producing and distributing super acid in Canada. Several American companies have made test runs with the intention of marketing the super acid when demand justifies it.

Laboratory studies were made to concentrate commercial wet-process phosphoric acid, which is less expensive to produce in most areas than electric furnace acid. Test showed that wet-process acid concentrated to about 70 per cent P_2O_5 was very similar to superphosphoric acid made by the electric furnace process and contained fewer solid impurities than ordinary wet-process acid. The construction of a pilot plant was started to continue study of the concentration step and to provide sufficient concentrate for testing its suitability in making high-analysis liquid and solid mixed fertilisers. Exploratory work was also done on high-analysis suspension fertilisers which, unlike clear liquid fertilisers, contain fine crystals and particles of impurities in suspension. They are more concentrated than usual liquid fertilisers—grades as high as 14–14–14 were made—and probably will be more economical in cost in most areas. These promising new fluid fertilisers are now attracting considerable attention in the industry.

Future Development

With the fiscal year 1959, the beginning of T.V.A.'s second quarter-century, it seems appropriate to sight ahead and explore some of the opportunities, challenges and problems that the coming years will present. An adequate supply of electricity is basic to the full development and use of most of the other resources of a region. It must be planned well ahead, for generating capacity takes much longer to install than power-consuming facilities. The legislation approved by Congress shortly after the end of the fiscal year, authorising T.V.A. to issue revenue bonds to finance additions to its power system, will enable T.V.A. to plan ahead in an orderly manner to meet the needs of the power consumers. The accompanying chart shows the actual growth of loads supplied with T.V.A. power, exclusive of Federal loads, from the beginning of calendar year 1950 to fiscal year 1959, and the estimated growth to fiscal year 1964. As seen from the chart, in the Tennessee Valley the power requirements of homes and farms, and businesses and industries, have been doubling on the average every six or seven years. This is equivalent to a rate of growth of about 12 per cent a year. Experience in the Tennessee Valley has demonstrated a potential in the demand for home and farm use of electricity which, from all signs,

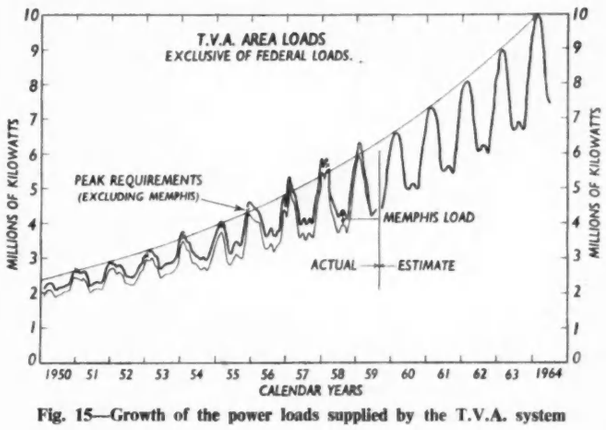


Fig. 15—Growth of the power loads supplied by the T.V.A. system

THE AMERICAN SCENE *(Continued)*

means a continued upward trend in the demands of these consumers. Industrial growth also will continue to require large amounts of additional power. The low-rate policy prescribed in the T.V.A. Act was reaffirmed in the revenue bond legislation. There is every reason to believe that past trends in electricity use in the area will continue as long as the low-rate policy remains in force.

To-day the average annual domestic use per residential customer in the region is nearing 8000kWh and twenty of the municipal distributors report averages on their systems in excess of 10,000kWh per customer. According to predictions, the national average domestic use of electricity is not expected to reach that level until 1975. With the many new uses of electricity that develop each year, and with the sharply increasing use for air-conditioning and heating, an average annual use of 20,000kWh per customer in the Valley region is not many years off. The home heated and cooled by electricity, once a rarity, uses from 20,000kWh to 40,000kWh a year. Farm use of electricity offers a field of development which has been barely tapped in view of the possibilities which lie ahead. Electrically operated materials-handling equipment, coupled with tractor power in the fields, can all but eliminate the hard manual labour of harvesting and handling feeds on dairy, poultry and livestock farms. Such equipment is beginning to make its appearance on the region's farms. Farm water systems are rapidly becoming more numerous ; where only a quarter of the farms had them five years ago, more than half the farm families have them to-day and the number is increasing rapidly.

The meaning of such growth for T.V.A. is that for some years to come it will have to add approximately 1,000,000kW of generating capacity annually to keep pace with the resulting power requirements. According to present estimates, the amount of investment required to meet increased loads will be about 175 million dollars in the fiscal year 1961 and 225 million dollars a year for the next few years. It is expected that about two-thirds of the investment funds will be provided from borrowings and the remainder from power earnings. The estimates of power requirements are made on the basis of continuing studies of the probable needs for each major class of service—municipal and co-operative systems, large industries, and Federal agencies. Reasonably accurate forecasts can be made for several years in advance ; they are revised as new data are obtained. The estimates assume a continued expansion of the economy of the region and of the country with a relatively high industrial production.

Trends of load growth and seasonal variations are projected from past experience. Forecasts of power use by the residential and farm customers of the municipal and co-operative electric systems are based on a number of independent studies of factors which affect power use. These include studies of growth in number of customers and past and future uses of electric appliances and their effect on power demand. The existing and prospective requirements of commercial and industrial enterprises served by the municipal and co-operative systems are similarly reviewed and projected. The requirements of the few large Federal and industrial enterprises served directly by T.V.A. are forecast on the basis of the best individual information available. In addition, an allowance is made for continued expansion in this class of service ; the margin is necessary to keep ahead of probable growth in demands since power-consuming facilities can nearly always be constructed in only a fraction of the time required to build the generating plants and units to serve them. An amendment to the T.V.A. Act authorising the issuance of electric revenue bonds for power construction, which became effective on August 6, 1959, opened the way to the much needed expansion of generating capacity to meet power requirements over the next few years. It is expected that the bonds authorised under the amendment together with that part of the earnings that will be available for reinvestment will meet the Authority's needs for the next five or six years.

Since the passage of the legislation, contracts have been let for two large steam-electric generating units, one of them of 500,000kW, the other of 600,000kW capacity—the latter being the largest single unit to be installed anywhere in the world. It has been decided to make the 600,000kW General Electric unit the initial installation in a plant to be built at Paradise, Kentucky, on the Green River adjacent to large coalfields. A contract for 65,000,000 tons of coal expected to supply the plant over a period of seventeen years has been concluded. A decision as to the location of the 500,000kW Brown Boveri unit has not yet been made. With the completion of these units, the installed capacity of the system will be increased from about 11,000,000kW at the end of fiscal year 1959 to nearly 13,800,000kW in 1963. They will provide the system with sufficient capacity to meet power requirements up to the winter of 1962–63. Other installations, however, must be started soon to meet power needs thereafter.

While most of the new capacity must, of necessity, be in large, coal-burning steam-electric plants, other sources of power are being studied for the more distant future. The T.V.A. staff is assisting the Atomic Energy Commission in investigating various reactor designs, including an experimental gas-cooled reactor project of about 25,000kW capacity to be built at Oak Ridge. When nuclear plants become economically competitive with coal-burning plants, T.V.A. will doubtless design and build some nuclear plants.

Although the major hydro-electric sites within the Tennessee River system have been developed, some possibilities remain for additional capacity. In fact, a number of minor undeveloped hydro-electric sites have been identified which might be developed economically in the future, particularly where multiple-use dams are involved. One such project, Melton Hill, on the Clinch River below Norris Dam, has been recommended to the Congress for construction to provide 72,000kW of hydro-electric capacity and to extend the navigation channel on this tributary. Other possible projects would provide combinations of flood control and power, or involve all three major purposes, including navigation.

With the growth of traffic on the waterway, it is becoming clear that larger locks must be installed in a number of the mainstream dams. It is estimated that by 1975 between 20,000,000 and 28,000,000 tons of freight will be moving annually on the waterway, compared with the present 12,000,000 tons a year. The construction of the new large single-lift lock at Wilson Dam, placed in operation in November, 1959, removed the most serious existing bottleneck to navigation. Until then tows had to pass through three locks at Wilson. The completion of this project provides large locks through all three of the dams on the lower end of the river—Kentucky, Pickwick Landing and Wilson. It is expected that traffic pressure will now exert itself on the locks next upstream. Studies for such a new large lock at Wheeler Dam, 15½ miles upstream from Wilson, are now being made. It appears that new large locks also will be needed within the next several years at Guntersville and Hales Bar dams. This would provide large-lock navigation from the Ohio River to Chattanooga, Tennessee, 450 miles above the mouth of the Tennessee. It is still to be seen whether or not it would be economical to extend the large-lock system through Chickamauga, Watts Bar and Fort Loudoun dams to the head of navigation at Knoxville.

Although a large amount of additional upstream storage for flood control is not indicated, there are several local situations where flood control works are desirable. One is at Chattanooga, where a levee system is needed to provide full protection of the city against the maximum probable flood by supplementing the protection provided by the T.V.A. flood control system. Another area where protection is desirable is in the upper French Broad River valley, where a system of detention reservoirs and channel improvement would benefit the city of Asheville, North Carolina, and extensive areas of agricultural land upstream from the city. There are other areas and communities where protective works may be desirable.

The growth of manufacturing in the T.V.A. area, as in the south-eastern part of the United States generally, has been affected by two important factors : (1) the whole American industrial economy was expanding ; and (2) the south-eastern area represented a kind of colonial or raw materials area where under-developed and under-used resources invited the development of industry. Industrial expansion has come in a period of transition in which the number of farms and farm employees has markedly declined. Much of the increased manufacturing activity in the region has come from the expansion of industries already in the Tennessee Valley ; this growth has just about equalled the growth in number of new works.

The resource development activities of the Authority have contributed to the growth in industry as, for example, in the improvement of water transportation, ample supplies of electricity, and the improved use of soil, forest, and mineral resources which provide the basis for expansion. However, this expansion has not taken place at the expense of other areas where industry also has grown, and often with the help of the same kind of resource development activity carried on by the Federal Government through other agencies. New businesses have been formed by individuals and firms in the T.V.A. area and new branch plants of companies have been built. Such new enterprises have been attracted for the usual complex of reasons—nearness to markets, availability of raw materials, plentiful labour supply, transportation and communication facilities, and others. Loosely made charges that low-cost power has lured industry away or "pirated" companies and works from other areas have collapsed when facts were faced. In view of the continued complaints, T.V.A. recently conducted a survey to discover the facts about the alleged migration of industry. During the nineteen years from 1940 to 1958, the survey indicated, twenty-five firms ceased operations in areas outside the T.V.A. region and moved into the region. They represented employment of 3800 people. During the same period, nine firms representing an employment of 2000 persons left the T.V.A. region for locations elsewhere. The net gain of sixteen plants and 1800 employees was negligible in the total growth of industry in the region, where the number of workers in manufacturing plants, according to census figures, increased from 175,000 to nearly 290,000 between 1939 and 1954.

Experiments with Low-Noise Antenna

EXPERIMENTS are being carried out by Bell Telephone Laboratories, New York, with low-noise antenna and maser-receiver systems as part of a study of the possibilities of an earth-based communication system using reflection from passive earth satellites. The receiving apparatus consists of a narrow-beam-width, highly-directional horn-reflector antenna with low noise pick-up, coupled with a low-noise travelling-wave maser that amplifies in one direction only. With the antenna pointed vertically upwards overall input temperatures of only 17·6 deg. K. (absolute) were observed at 5·65kMc/s, representing the combined noise contribution of the sky, antenna and maser amplifier. Improvements now in hand indicate the feasibility of systems having an overall noise temperature of 7·5 deg. K. at 6kMc/s for reception near vertical.

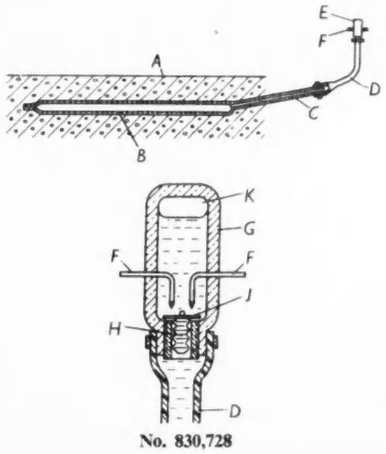
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

TRAFFIC SIGNALLING

830,728. June 25, 1958.—HYDRAULICALLY OPERATED ELECTRIC SWITCH, N. Jacobsens Elektriske Verksted A/S, Göteborggt 38, Oslo, Norway.

The present invention relates to hydraulically-operated electric switch devices, especially of the kind used for traffic registration but which may also be used in many other fields. In the upper drawing, showing a roadway installation, a concrete or asphalt paving *A* has a container *B* embedded therein which has the form of a flattened or oval steel tube. Through a substantially narrower tube *C* and a hose *D* of rubber or similar material the container is connected with a switch device *E* having two fixed contact pins *F* connected with an external circuit, not shown. The whole tube system is closed and filled with an electrically insulating liquid pressure medium such as petroleum or white spirit. As shown in the lower drawing the switch device is disposed in a housing *G* having the form of a bottle turned upside down. In the wall the two contact pins *F* are sealed in, or pass through the wall in some other liquid-tight manner. The movable part of the device consists of a piston *H* carrying at its top a contact disc *J* which is tiltably attached to the upper end of said piston which is, for this purpose, formed with a small round head. The piston is arranged with good clearance



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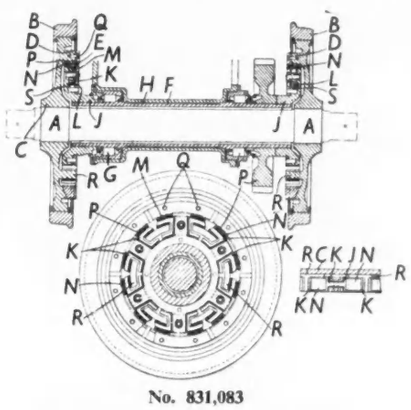
in a cylinder which is open at both ends and threaded into the neck of the bottle-shaped housing. Through the rubber hose *D* the bottle is connected with the tube system. The clearance between the piston and the wall of the cylinder forms a by-pass for the pressure medium which will cause the pressure in the tube system *B*, *C*, *D* rapidly to equalise over the complete system, of which the housing *G* also forms a part, after a pressure wave has acted upon the piston and thereby closed the circuit through both contact pins and the contact disc. Thus impulsive operation is obtained even when the operating pressure lasts for a long time, as when a vehicle comes to rest with its wheels on the detector. In order that the turbulence of the liquid shall be utilised to the maximum possible extent for lifting the piston, the piston has a varying cross section when seen in the axial direction, such as being formed like a screw, or, as illustrated, with ring-shaped corrugations of a sinusoidal contour. The closed tube system shown in the drawings is not completely filled with pressure medium, a gas bubble *K* being provided in the upper part of the bottle which absorbs the volume variations of the tube system and which is necessary for enabling the switch device to function correctly.—*March* 16, 1960.

ELECTRIC TRACTION

831,083. August 7, 1956.—IMPROVEMENTS TO TRACTION VEHICLES WITH AXLE-HUNG MOTORS, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4. (*Inventor: Frank Whyman.*)

In some quill-drive constructions the coupling between quill and axle is achieved by rubber pads in shear or compression or a combination of both. Such systems have the difficulty that the rubber may sometimes become permanently deformed, thus causing the bearings to run somewhat eccentrically. This undesirable condition is aggravated as the rotational speed of the axle increases. It is an object of this invention to reduce such difficulties by providing a construction which normally maintains the axle and a surrounding hollow shaft supporting the motor substantially concentric with each other unless a momentary impact on the wheels produces a force sufficient to displace the shaft and axle momentarily from their concentric relationship. Referring to the drawings, the wheel axle *A* carries at each end a wheel *B*, the hub or centre portion *C* of which is formed on its inside face with a circumferential flange *D*, providing a slightly conical surface *E* facing radially inwardly. The axle is surrounded between the wheels by a hollow quill shaft *F* which supports in suspension bearings *G* an axle-hung traction motor part of the yoke of which is indicated at *H*. The



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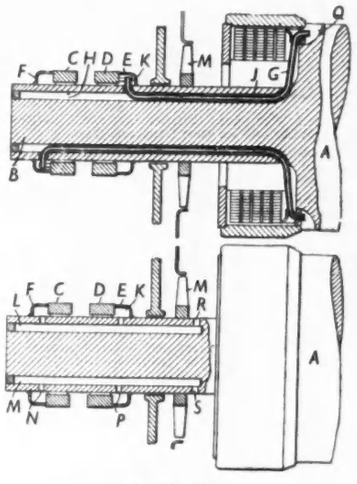
quill shaft carries adjacent the wheel a spider structure *J*. The legs of the spider serve as radial guides for bearing members *K*, formed with arcuate inwardly facing surfaces *L* which match and are normally held in engagement with a facing circumferential surface on the spider. Members *K* are also formed with arcuate outwardly facing surfaces *M* between which and the flange surfaces *E* on the wheel centre are interposed resilient pads *N* of rubber or other suitable material. These pads are normally held in compression by the action of wedge-shaped segmental liners *P*, the outer surfaces of which bear on the conical flange surfaces on the wheel centre. When the bolts *Q* are tightened on assembly of the parts, the segmental wedge-shaped liners act through the pads to urge the inner surfaces of the bearing members *K* into firm engagement with the facing spider surface, giving the required compression to the pads *N* in doing so. The inside face of the wheel centre is also formed with arcuate projections *R* located between the legs of the spider. Each of these projections protrudes under lips on the adjacent bearing members at each side of the projection, radially inward movement of the bearing members with respect to the wheel being thereby restricted. With no vertical loading on the quill the precompressed pads *N* hold the bearing members *K* against the surface *S* of the spider and the quill runs concentrically with the axle. Any downward load on the quill tending to displace it from the concentric position results in compressing the lower pads *N* and extending the upper ones. For loading higher than the critical value, the upper bearing members *K* will remain suspended on the projections *R*, engaging them while the associated spider legs slide past them as the spider descends, taking with it the lower bearing members *K* and also those then occupying lateral positions. This displacement of the spider continues until the load is balanced by the compressive forces produced in the lower pads *N* and the shear forces produced in the lateral pads.—*March* 23, 1960.

ELECTRICAL ENGINEERING

831,794. September 4, 1956.—ELECTRICAL TURBO-GENERATORS, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1-3, St. Paul's Churchyard, London, E.C.4. (*Inventors: William Norman Kilner and Joseph Tudge.*)

The requirements of turbo-alternators have recently tended towards increased outputs and since the physical dimensions of these machines cannot, in many cases, be conveniently increased, it has been necessary to increase the current loading on the conductors. As the collector rings are located outside the casing of the machine increasing their current carrying capacity does not present an undue difficulty. However, the leads between the collector rings and the rotor winding have to pass between the collector rings outside the casing and the rotor winding within the casing, which, in the case of hydrogen cooled machines, forms a gas seal with the shaft. In view of this it has been normal practice to pass the leads along bores within the actual shaft. It follows, however, that with such constructions the current density is liable to be limited by the temperature rise in the leads. In the arrangement of this invention as shown in the drawing, *A* is the

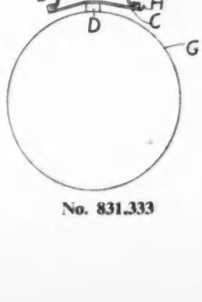


No. 831,794

rotor body and *B* the shaft end. References *C*, *D* indicate the two collector rings respectively. Shroud rings *E*, *F* form gastight annular inlet gas chambers. The collector lead *G* electrically connects the collector ring *D* to the first turn of the rotor winding. In the arrangement shown in the drawing the lead is located in an axially drilled hole *H* in the shaft end. The leads are of a hollow construction forming a central duct *J*, the inlet end of which communicates with the annular inlet chamber *K*. Gas is admitted to the chambers feeding the collector leads from axial bores *L* and *M* which are fed with cooling gas from inside the machine case through holes *R*, *S*, preferably on the pressure side of propeller fan *M*. The inlet bores are connected with the annular chambers through ports *N*, *P*. Cooling gas passing along the duct *J* in the lead *G* discharges into the recess *Q* which is open to the annular gap between rotor and stator. Collector ring *C* is similarly connected with a turn at the opposite end of the winding by a hollow conductor in a duct diametrically opposite to duct *H*.—*March* 30, 1960.

831,333. May 17, 1956.—COLLECTOR BRUSH GEAR, Minister of Supply, London. (*Inventor: Arthur Thomas Backlog.*)

The present invention is concerned with providing electrical brush gear for dynamo electric machines of which the brush is capable of following the commutator profile at high speeds. A preferred form is shown in the diagram, wherein the brush gear com-



No. 831,333

prises a spring *A* having cantilever spring arms *B*, and a thin beryllium-copper strip *C* secured at its ends to the ends of the arms and carrying a carbon brush *D*. The spring is secured to an electrically insulating mounting block *E* which is adjustably secured to the casing of a dynamo electric machine by screws *F*. The arms *B* apply tension to the strip *C* and the brush gear is set up in the position shown by adjustment of the block *E* on the machine casing (not shown), so that the brush is in contact with a commutator *G* and the strip is deflected from the straight position. It will be seen, therefore, that the tension in the strip urges the brush into contact with the commutator. Furthermore, movement of the ends of the arms to which the strip is secured resulting from any up and down movement of the brush will be small compared with the actual brush movement. It is for this reason that the connecting tag *H* is located at one end of the strip *C*. Thus the momentum of the brush and associated mounting following contact with a "high" commutator segment is low compared with the more normal spring type of brush mounting and the tendency of the brush to remain out of contact with the commutator following contact with a high segment is greatly reduced. Provision may also be made for adjusting the arms *B* relative to one another so that the position of the brush may be adjusted for varying speeds of the commutator.—*March* 30, 1960.

Catalogues and Brochures

G. AND J. WEIR, Ltd., Cathcart, Glasgow, S.4.—Illustrated booklets dealing with sea water distillation plant.

MIDLAND SILICONES, Ltd., 68, Knightsbridge, London, S.W.1.—Technical booklet describing the engineering applications of Silicone fluids.

OIL BURNER COMPONENTS, Ltd., Vines Lane, Droitwich.—1960 Catalogue listing a range of automatic heating components and accessories.

J. P. SANDERS AND CO. (TRUTOOLS), Ltd., 15A, Campbell Road, Croydon, Surrey.—Illustrated leaflet describing the "Parometer," a parallel comparator.

METALLECTRIC FURNACES, Ltd., Resistance Furnace Division, Cornwall Road, Smethwick, 40, Staffs.—Leaflet No. M.10A entitled "Vitrous Enamelling Equipment."

E.M.O. INSTRUMENTATION, Ltd., Western Road, Bracknell, Berks.—Revised catalogue containing descriptions, specifications, applications, dimensions and performance data for standard E.M.O. precision bearings.

NIAGARA SCREENS (GREAT BRITAIN), Ltd., Straysfield Road, Clay Hill, Enfield.—Leaflet C.1 giving details of screens used in the coal industry. Leaflet R5 illustrating and describing equipment for use in oil fields.

CAWKELL RESEARCH AND ELECTRONICS, Ltd., Scotts Road, Southall, Middlesex.—Leaflet describing a transient storage oscilloscope, the "Remscope." The leaflet gives details of the method of operation, and describes the principle of the storage tube.

THE GENERAL ELECTRIC COMPANY, Ltd., Magnet House, Kingsway, London, W.C.2.—The M.O. Valve Company, Ltd. (a subsidiary of The General Electric Company, Ltd.) 1960 edition of its catalogue of G.E.C. valves and cathode ray tubes for industry. Several hundred devices are listed under some twenty main groups.

RANK-XEROX, Ltd., 33–41, Mortimer Street, London, W.1.—A sixteen-page booklet describing some of the applications of manually-operated xerographic equipment. The production of offset litho plates, dyeline masters, spirit masters, and direct copies is explained, and the uses of the equipment in the print department, for office duplicating, drawing office work, library systems and filing are described.

W. AND T. AVERY, Ltd., Soho Foundry, Birmingham, 40.—Illustrated brochure entitled "How Avery Helps Industry" describing some applications of the "Avery" electronic switch, which provides a means whereby operation of a scale will automatically energise or de-energise an external circuit to control any mechanism normally operated by electricity or by electro-pneumatics. Many examples of scientific and controlled weighing are illustrated in the brochure.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., April 26.—EAST KENT BRANCH: County Hotel, Canterbury, "Electricity in Agriculture," J. Cowan, 8 p.m. ★ OXFORD AND DISTRICTS BRANCH: Employment Exchange, Oxford, "Crime Prevention and Lighting," 8 p.m.

Thurs., April 28.—SOUTH LONDON BRANCH: Greyhound Hotel, High Street, Croydon, Surrey, "Static Electricity in Industry," S. J. Emerson, 8 p.m.

Fri., April 29.—COVENTRY AND DISTRICT BRANCH: Visit to Coventry Telephone Exchange, 7.30 p.m.

BRITISH COMPUTER SOCIETY

Thurs., April 28.—BELFAST BRANCH: 29, University Square, Belfast, Annual General Meeting, 7.15 p.m. ★ SOUTH WALES AND MONMOUTHSHIRE BRANCH: Small Shandon Lecture Theatre, University College, Cardiff, Symposium on "Auto Codes," 6.30 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Fri. and Sat., April 29 *and* 30.—Gleneagles, Scotland, 1960 Scottish Conference on "Management Problems in an Expanding Economy."

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., April 27.—LONDON BRANCH: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Electronics in Oceanography," M. J. Tucker, 6.30 p.m.

Thurs., April 28.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Annual General Meeting, and Technical Films, 6.30 p.m.

Fri., April 29.—SOUTH MIDLANDS SECTION: North Gloucestershire Technical College, Cheltenham, "The Application of Semiconductor Devices in Power Supplies," D. D. Jones, and Annual General Meeting, 7 p.m.

BRITISH INTERPLANETARY SOCIETY

Thurs., April 28.—Hoare Memorial Hall, Church House, London, S.W.1, "High Altitude Chambers and Pressure Suits," E. W. Still, 7 p.m.

CEMENT AND CONCRETE ASSOCIATION

Wed., April 27.—Building Centre, 26, Store Street, London, W.C.1, "Pyrodeck Roof Construction," 12.45 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., April 26.—SCOTTISH REGION: Douglas Hotel, Galashiels, Films on "Atomisation" and "Clean Air Act," followed by a Discussion on "Modern Methods of Oil Firing," opened by R. A. Dunlop, 10.30 a.m., and Discussion on "The Utilisation of Small Coals," opened by R. Cleland, 2 p.m. ★ NORTH WESTERN REGION: Engineers' Club, Manchester, "The Working of the Clean Air Act Over the Past Twelve Months," J. E. Richards, 2.30 p.m.

Thurs., April 28.—WESTERN REGION: Park Hotel, Cardiff, "Research Towards Improving Mechanisation and Automatic Control in Industrial Coal-Fired Boilerhouses," G. G. Thurlow, 10.30 a.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., April 25.—BIRMINGHAM CENTRE: Regent House, St. Philip's Place, Colmore Row, Birmingham, Film Show, 6 p.m. ★ LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, Annual General Meeting, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., April 27.—LONDON BRANCH: Constitutional Club, Northumberland Avenue, London, W.C.2, Annual General Meeting, and "Foundry Coke—Production and Utilization," J. P. Graham, and L. W. Bolton, 7 p.m. ★ SOUTHAMPTON SECTION: Technical College, St. Mary's Street, Southampton, Annual General Meeting, and Lecture and Film on "Dust Extraction and Dressing," W. B. Lawrie, 7.30 p.m.

INSTITUTE OF FUEL

Wed., April 27.—LONDON BRANCH: Institution of Civil Engineers, Great George Street, London, S.W.1, Presidential Address, 5.30 p.m.

Thurs., April 28.—LONDON BRANCH: Connaught Rooms, London, W.C.2, Annual General Meeting, 11.30 a.m. ★ EAST MIDLAND SECTION: Gas Showrooms Lecture Theatre, Nottingham, Annual General Meeting, and "Nuclear Power—The New Power Stations," G. T. Shepherd, 6.15 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., April 25.—WEST OF ENGLAND SECTION: Small Engineering Lecture Theatre, The University, University Walk, Bristol, 8, Films, "An Introduction to the Heat Engine"; "British Adventure," and "Journey from the East," 7.30 p.m.

Tues., April 26.—The Memorial Building, 76, Mark Lane, London, E.C.3, Annual General Meeting, 5.30 p.m.

INSTITUTE OF METALS

Wed., April 27.—METAL PHYSICS COMMITTEE: 17, Belgrave Square, London, S.W.1, "Deformation and Fracture of Ionic Crystals," J. Washburn, 6.30 p.m.

INSTITUTE OF NAVIGATION

To-day, April 22.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The Economics of Ship Routing," G. L. Hansenn and R. W. James, 5.15 p.m.

INSTITUTE OF SHEET METAL ENGINEERING

Tues., April 26.—SOUTH-WEST BRANCH: Department of Engineering, The University, Bristol, Forum, "Future Developments in the Steel Industry," 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., April 26.—Great George Street, Westminster, London, S.W.1, "Design, Fabrication and Erection of the Ganga Bridge," S. G. Savarkar, S. Turley, J. Williams and R. J. C. Tweed, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, April 22.—EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, Discussion on "Broadening University Courses," opened by H. E. M. Barlow, 6 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Duncan Hall, Stone, "The Application of Transistors to Line Communication Equipment," H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead, 7 p.m.

Mon., April 25.—LONDON GRADUATE AND STUDENT SECTION: Savoy Place, London, W.C.2, "A Survey of Microwave Techniques for the Transmission of Speech and Vision," K. C. Kao, 6.30 p.m. ★ SOUTH MIDLAND ELECTRONICS AND MEASUREMENT GROUP: James Watt Memorial Institute, Birmingham, "The Challenge of the Propagation Medium to the Radio Engineer," G. Millington, 6 p.m.

Tues., April 26.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "An Experimental Transistor-Controlled Component Selection and Testing Machine," T. C. Cardwell, J. R. W. Smith and G. H. King, 5.30 p.m. ★ NORTH MIDLAND UTILISATION GROUP: Leeds and County Conservative Club, South Parade, Leeds, 1, "Silicone Electrical Insulation," J. H. Davis, 6.30 p.m.

Wed., April 27.—ELECTRONICS AND COMMUNICATIONS SECTION: Savoy Place, London, W.C.2, "Henri de France Colour Television System," R. Chaste and P. Cassagne, 5.30 p.m. ★ SHEFFIELD SUB-CENTRE: Royal Hotel, Cleethorpes Road, Grimsby, Second Hunter Memorial Lecture, "The Protection of Electrical Systems," H. G. Bell, 7 p.m.

Thurs., April 28.—ORDINARY MEETING: Savoy Place, London, W.C.2, "Radar Observations of Birds and 'Angels,'" E. Eastwood, 5.30 p.m.

Fri., April 29.—SOUTH MIDLAND EDUCATION DISCUSSION CIRCLE: College of Technology, Gosta Green, Birmingham, Discussion on "The Generalized Analysis of Electrical Machines," opened by J. G. Henderson, 6 p.m. ★ NORTH EASTERN GRADUATE AND STUDENT SECTION: Grey Hall, King's College, Newcastle upon Tyne, 1, Annual General Meeting and Film Show, 6.30 p.m.

Sat., April 30.—LONDON GRADUATE AND STUDENT SECTION: Visit to Bankside Power Station, London, S.E.1, 10.30 a.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., April 27.—Midland Hotel, Bradford, Films, "From Strength to Strength," and "1000 Miles in Fourteen Hours," 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., April 26.—GENERAL MEETING: Lecture Hall, Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Steel Wheels and Tyres," C. F. Ryan and B. B. Hundy, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Mon., April 25.—INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "A Comparison of Anglo-American Productivity Figures," 6 p.m. ★ MIDLAND GRADUATES' SECTION: Engineering Centre, Stephenson Place, Birmingham, "Problems of Erosion and Corrosion in Wet Dust Extraction Plant," A. B. Arnison, and "Marine Lighthouse Design and Construction," J. A. Fletcher, 7 p.m.

Tues., April 26.—LONDON GRADUATES' SECTION: Visit to E.M.I., Ltd., Hayes, 2 p.m.

Wed., April 27.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, Annual Meeting and Film Show, "The Rival World," 6 p.m. ★ WESTERN A.D. CENTRE: Royal Hotel Bristol, "Car Engines," S. S. Tresilian, 6.45 p.m. ★ EASTERN GRADUATES' SECTION: Visit to British Timken, Duston, Northampton, 7 p.m.

Thurs., April 28.—LONDON GRADUATES' SECTION: 1, Birdcage Walk, Westminster, London, S.W.1, "Papermaking," T. J. Davies, 6.30 p.m.

Fri., April 29.—COVENTRY GRADUATES' A.D. CENTRE: Visit to Coventry Climax Engines, Ltd., 6 p.m.

INSTITUTION OF PLANT ENGINEERS

Mon., April 25.—WEST AND EAST YORKSHIRE BRANCH: Houldsworth School of Applied Science, The University, Leeds, "The Yorkshire Motorway," J. Michie, and Film, 7.30 p.m.

Tues., April 26.—SOUTH WALES BRANCH: South Wales Institute of Engineers, Park Place, Cardiff, "Heating and Air Treatment in Industry," A. A. Field, 7.30 p.m.

Thurs., April 28.—MERSEYSIDE AND NORTH WALES BRANCH: The Blossoms, Chester, "Selection of Pumps," 7.15 p.m. ★ SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Mechanical Principles of Quarrying Equipment," K. Holland, 7.30 p.m.

Fri., April 29.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Materials Handling—Fork Trucks, &c., Maintenance and Repairs," 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Sat., April 23.—NORTH MIDLANDS REGION: Welfare Hall, Rolls-Royce, Ltd., Derby, One-day conference, "The Production Engineer in a Changing Economy," 9.30 a.m.

Mon., April 25.—NORTH WESTERN REGION: Great Hall, Manchester College of Science and Technology, Sackville Street, Manchester, "Recent Developments in the Design and Construction of Ships," R. V. Turner, 6.30 p.m.

INSTITUTION OF WATER ENGINEERS

Wed., April 27.—SOUTH EASTERN SECTION: Institution of Civil Engineers, Great George Street, London, S.W.1, Annual General Meeting and Two Papers, 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Fri., April 29.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "A Journey from Venice to Dubrovnik," G. V. Rickards, 7 p.m.

NORTH COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Mon., April 25.—Lecture Theatre, Mining Institute, Neville Hall, Newcastle upon Tyne, "The Responsibilities of a Company Director," J. R. Mackay, 6.15 p.m.

PLASTICS INSTITUTE

Sat., April 23.—SOUTHERN SECTION: Visit to Southampton Gas Works, 2.30 p.m.

Fri., April 29.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Fibre Resin Preform Moulding," A. Lewin, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Fri., April 29.—WEST OF ENGLAND BRANCH: New School of Engineering, The University, Bristol, "Precasting in Concrete Framed Construction," J. F. Greinig and R. C. Westbrook, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

To-day, April 22.—AGRICULTURAL AVIATION GROUP: Library, 4, Hamilton Place, London, W.1, Discussion on "Pilot Training," 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

To-day, April 22.—CORROSION GROUP EDUCATION PANEL: 14, Belgrave Square, London, S.W.1, Conference on "Teaching Corrosion Science to Engineers," 11 a.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., April 26.—CONTROL SECTION: Manson House, 26, Portland Place, London, W.1, Annual General Meeting, and "Some Recent Advances in Industrial Electrical Control Techniques," T. E. Barany, 6.15 p.m.

WORK STUDY SOCIETY

To-day to Sun., April 22 *to* 24.—Grand Atlantic Hotel, Weston-super-Mare, Working Conference on "Measurement and Management."

Advanced Engineering Courses

The Design of High Voltage Transmission Systems. UNIVERSITY OF DURHAM, KING'S COLLEGE DEPARTMENT OF EXTRA-MURAL STUDIES, Chemistry Lecture Theatre No. 1, College Walk, King's College, Newcastle upon Tyne. A course of six lectures: Monday, April 25, 6.15 p.m, Hypothesis; Monday, May 2, 6.15 p.m., Synthesis; Monday, May 9, 6.15 p.m., Analysis; Monday, May 16, 6.15 p.m., Characteristics of Main Equipment; Monday, May 23, 6.15 p.m., Protection, Control and Communication; Friday, May 27, 6.15 p.m., System Performance and Operation. Fee £1.

Compact High Performance Heat Transfer Surfaces. NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, St. John Street, London, E.C.1. Two lectures by Professor W. Kays, Wednesday, April 27, and Wednesday, May 4, at 7 p.m. Fee 10s.

Nuclear Power Plant Design. NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY, St. John Street, London, E.C.1. A short course, intended to give a general survey of those sciences and technologies which are necessary in the design of nuclear power plant and to review the special problems associated with this design. The emphasis will generally be upon the nuclear-powered electric generating station, but mention is made of marine applications. The course, which runs from Monday, May 2 to Friday, May 13, will be conducted in conjunction with Atomic Power Constructions, Ltd., and Babcock and Wilcox, Ltd. Fee, twenty guineas.

The Forecasting and Scheduling of Production. THE UNIVERSITY OF BIRMINGHAM, INSTITUTE FOR ENGINEERING PRODUCTION, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. The course is intended to assist companies attempting to anticipate changes in the level of demand for their products in order to schedule production at a more even rate. The need for forecasting is first considered and techniques of forecasting are dealt with in detail, together with systems of making and modifying schedules from this information. The course will be held from May 16 to 20. Inclusive charge thirty-five guineas (resident), thirty guineas (non-resident).

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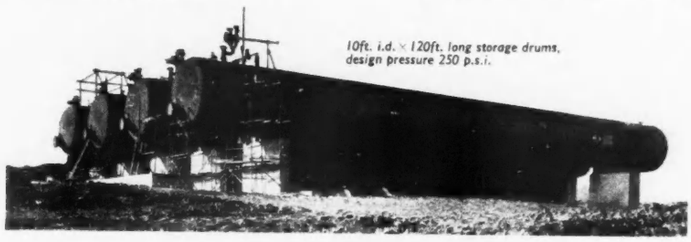

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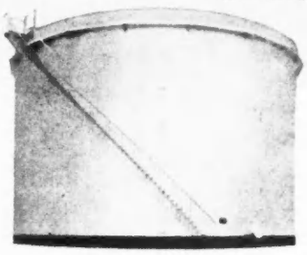

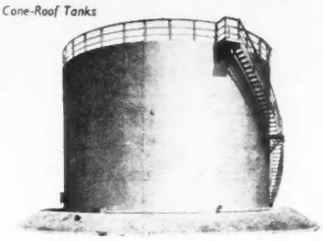

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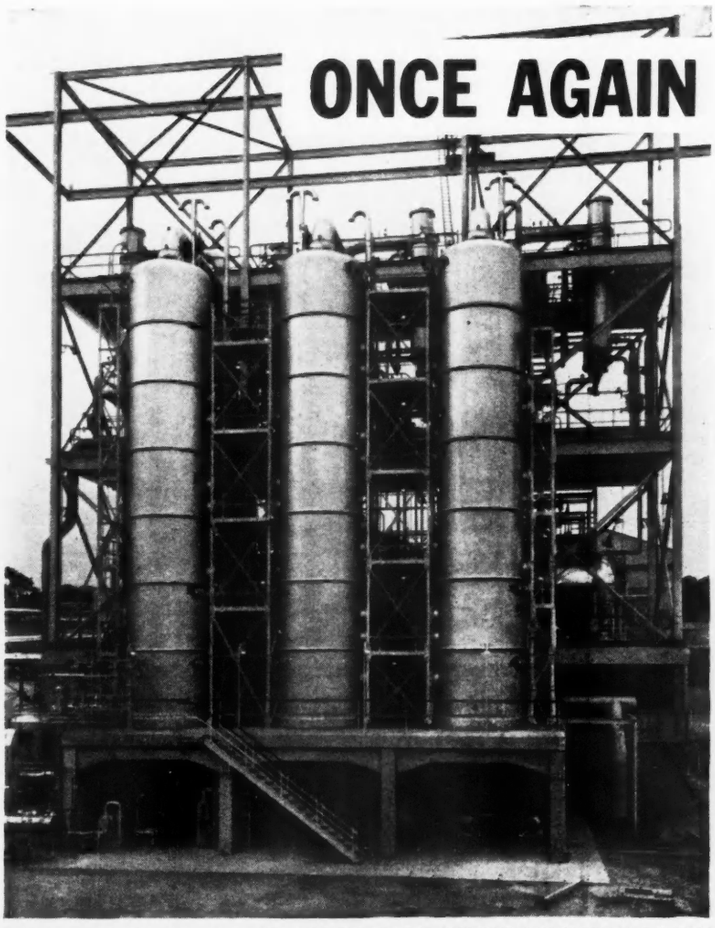

ONCE AGAIN VALVES BY CRANE

The new plant of The International Synthetic Rubber Company Ltd. at Hythe on Southampton Water is now in production in a big way. Once again Crane valves are playing an important part. The illustration *left* shows the recovery building, where the steam lines to the Styrene Strippers have been fitted with Crane 12 inch, 10 inch and 6 inch cast steel gate valves. In the administrative buildings too, Crane equipment is used, the central heating and domestic installations being very largely fitted with Crane Bronze Globe and Gate Valves. More and more industries are discovering that the name of Crane is synonymous with dependability.

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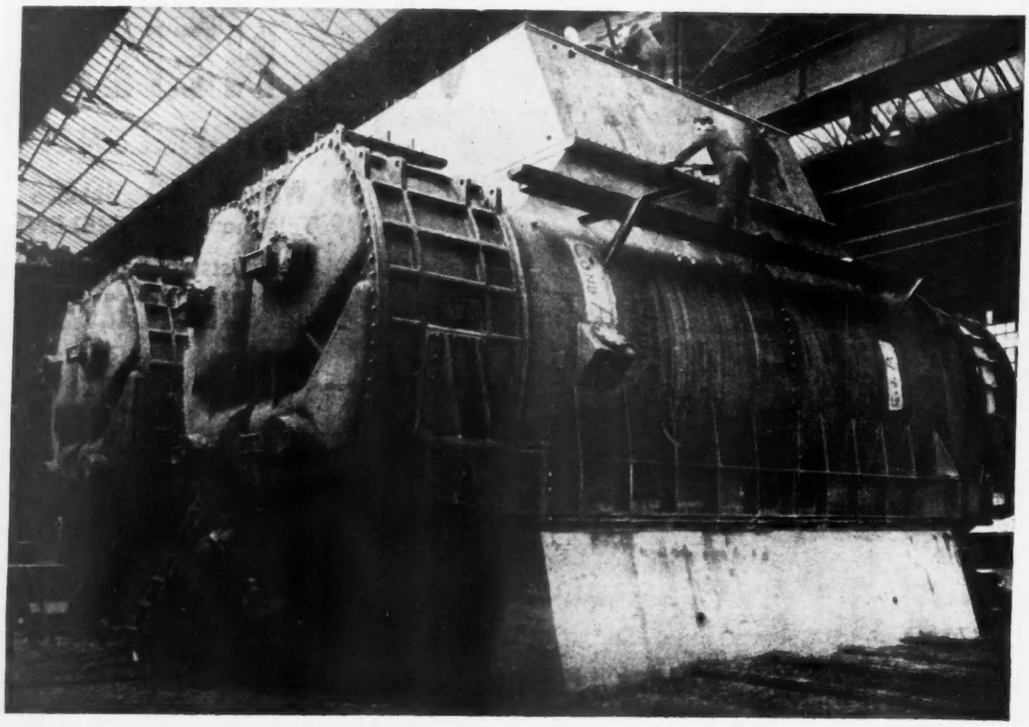

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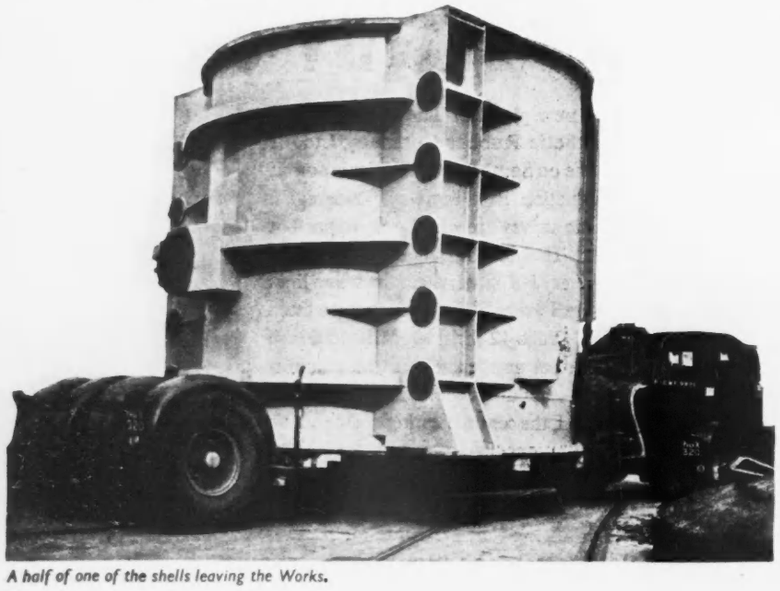

A half of one of the shells leaving the Works.

This is the first of four Weir Regenerative Condensers for the 120 MW Turbo-alternators at the C.E.G.B. Skelton Grange "B" Power Station. Each shell is 25 ft. 9 in. long and 14 ft. in diameter, and the total cooling area is 85,000 sq. ft (over 60 miles of tubing !).

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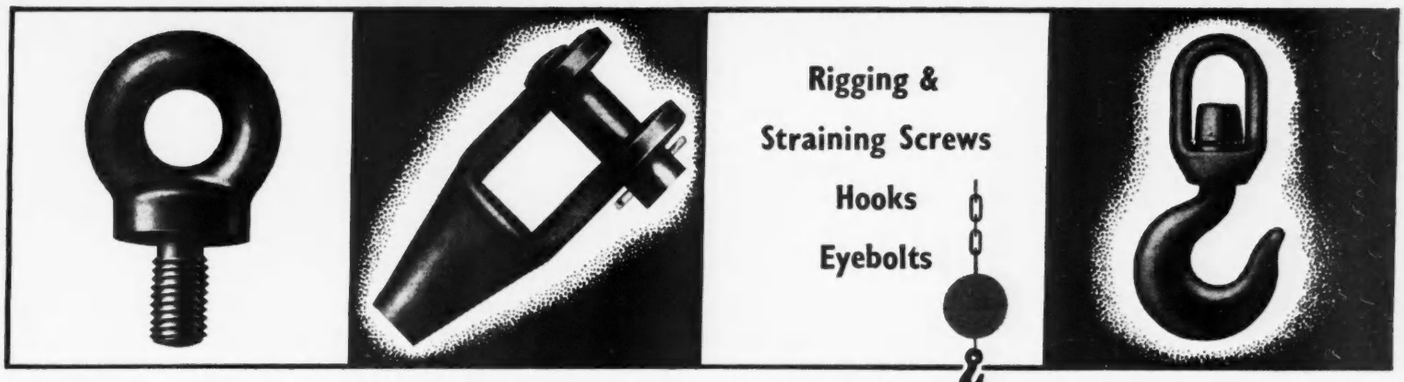

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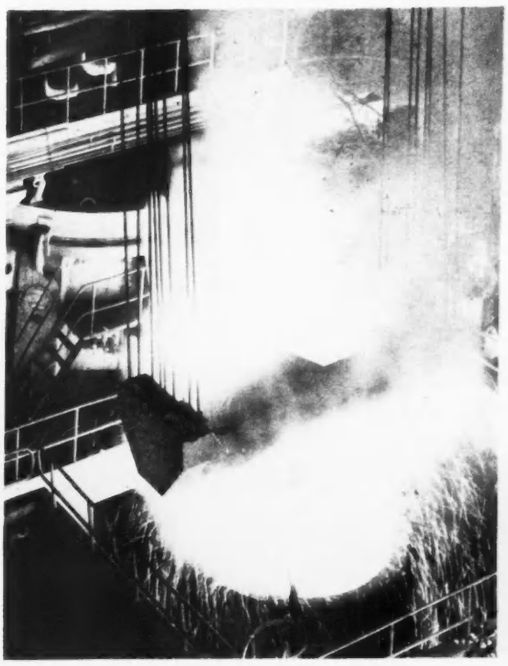

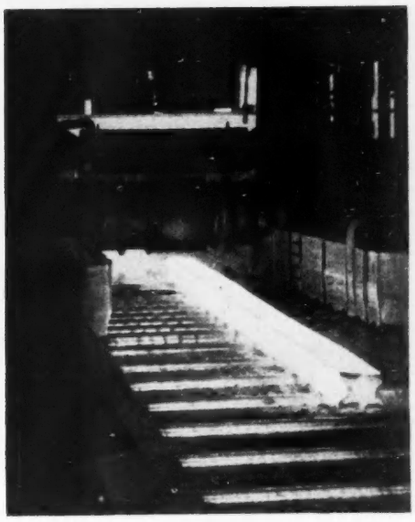

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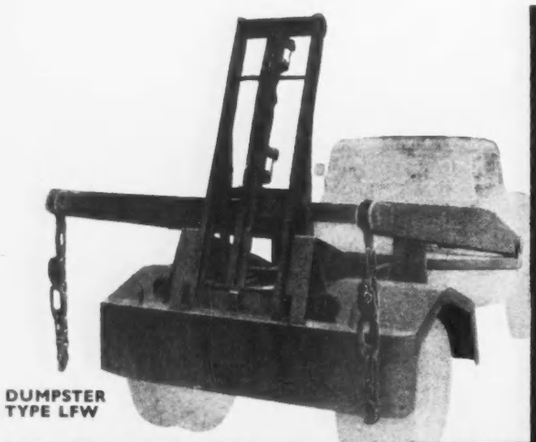

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TILT TYPES

Illustrated above is the type LFW. The assembly with hydraulic operation is mounted on a standard chassis. This will handle tilt type and drop bottom containers. The illustrations below feature the type GRD which again handles both tilt type and drop bottom containers with a fork lift specifically designed for high dumping.

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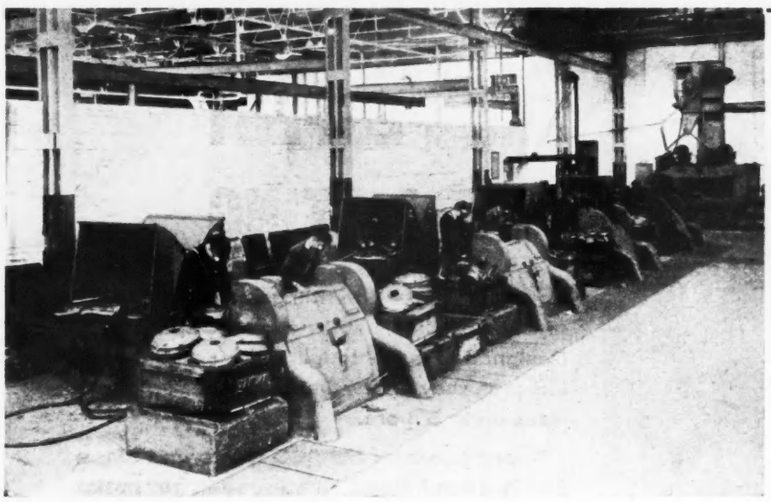

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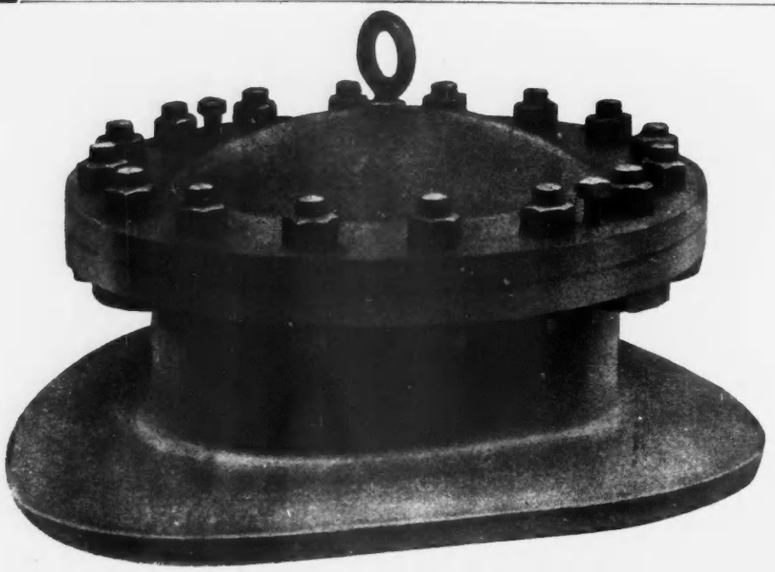

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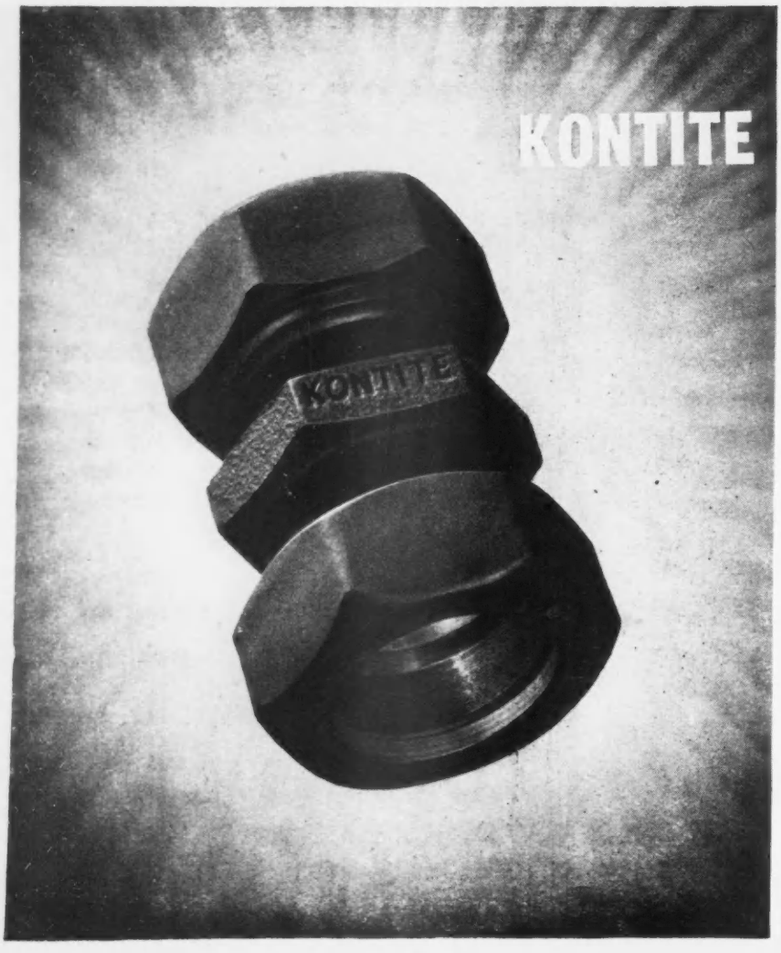

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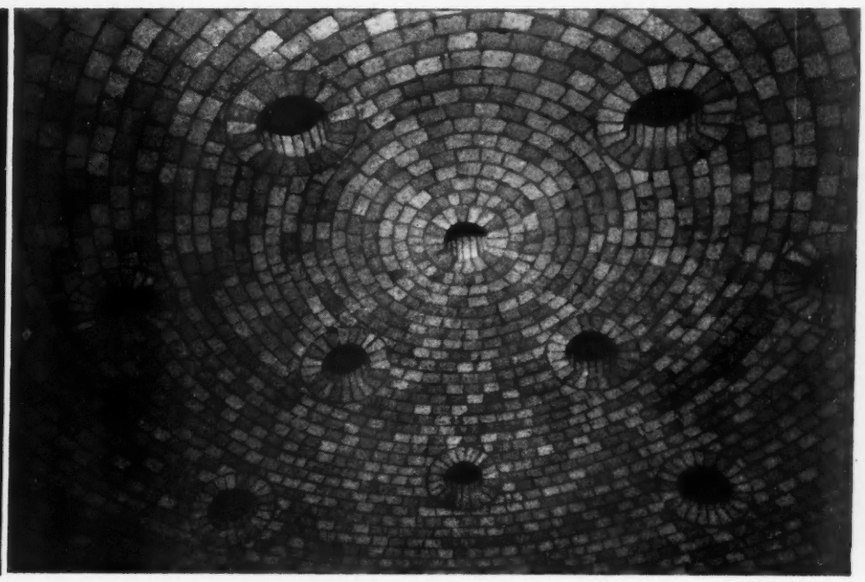

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. . .(MI. 28 bricks) . . . and like it

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from 3″ size upwards

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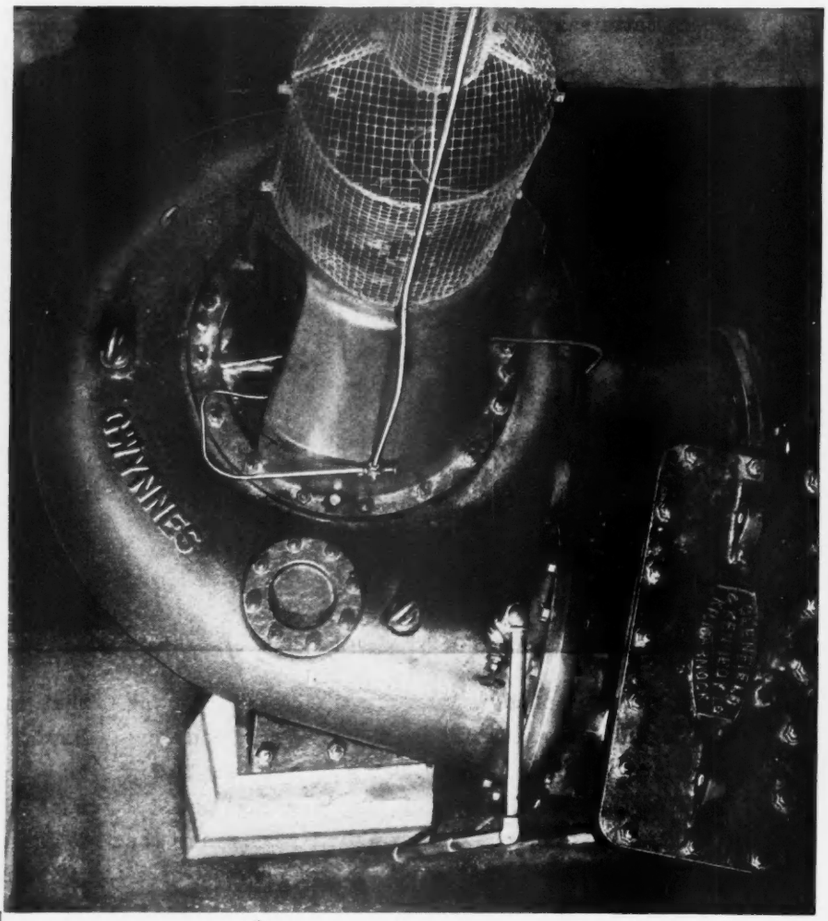

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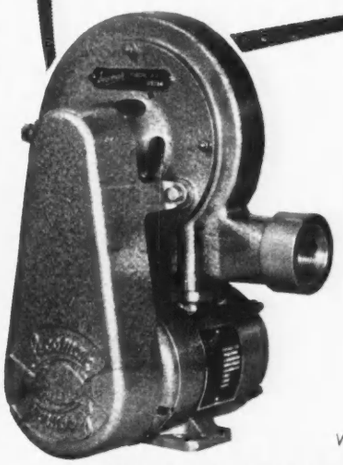

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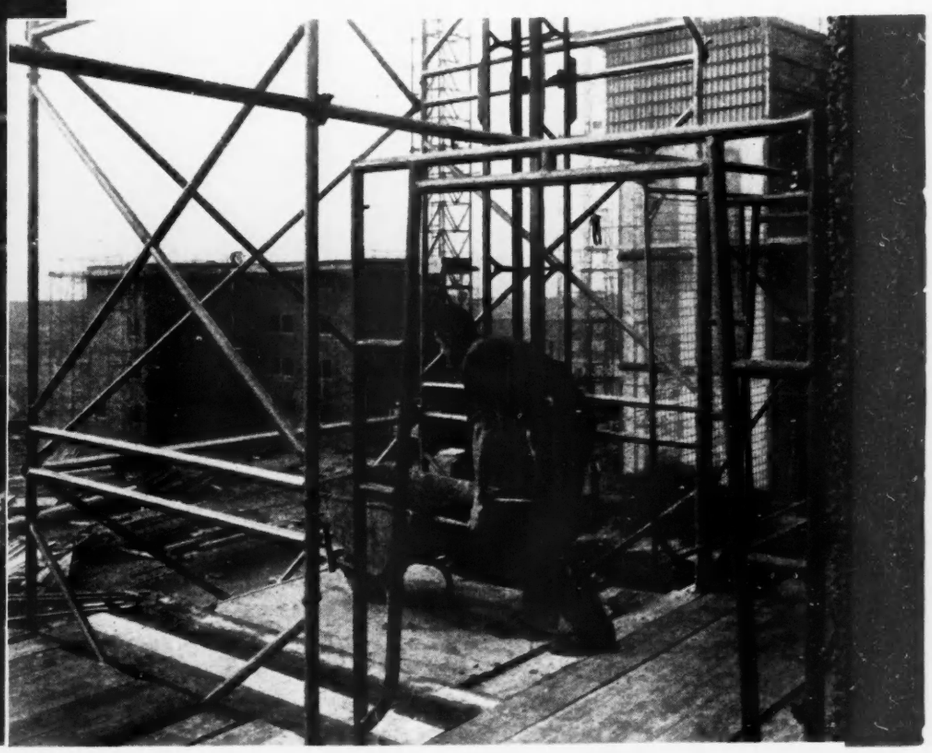

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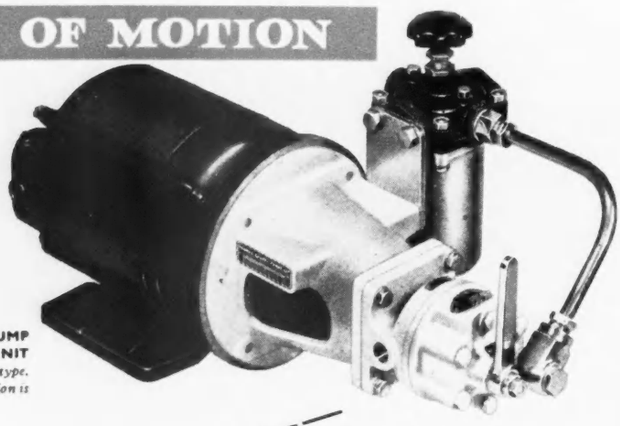

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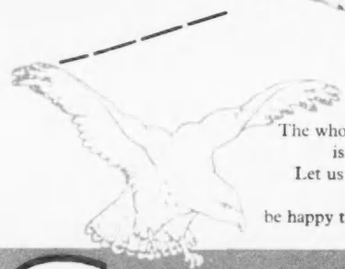

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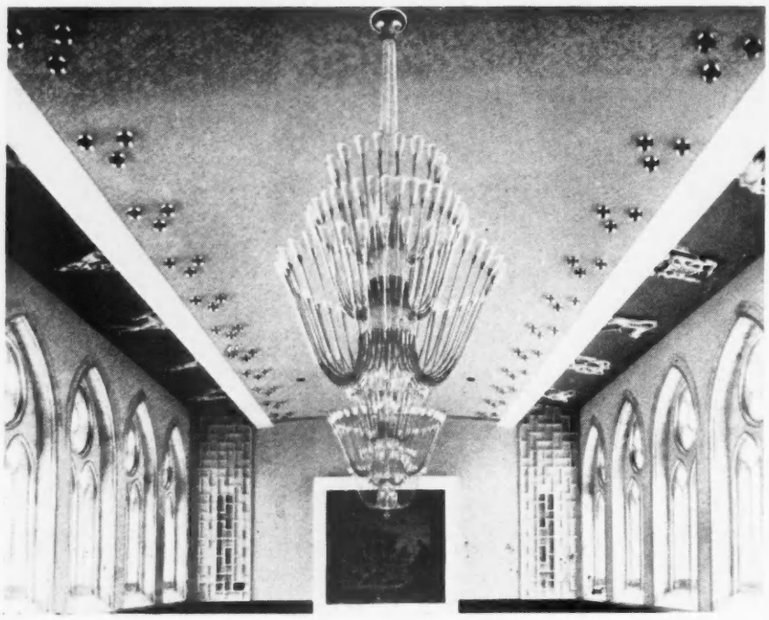
This equipment enables servicing to be carried out easily and quickly at floor level, but is entirely concealed when the fitting is returned to position. The design of walls and ceiling is not affected in any way.



London Electric Firm Ltd. is constantly solving similar problems involving many different forms of lighting equipment and ceiling construction. It is of great importance that the installation of L.E.F. Raising and Lowering Gear should be discussed at the planning stage, so that the simplest and most economical equipment can be built-in.

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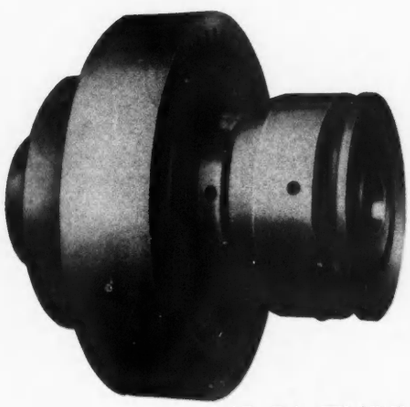
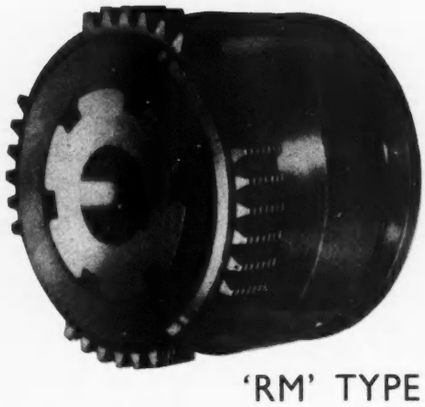


'RO' TYPE



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But today excruciating thrills await,
When starting do not be startled
If the pump does not start,
Check for—a speck in the impeller eye!
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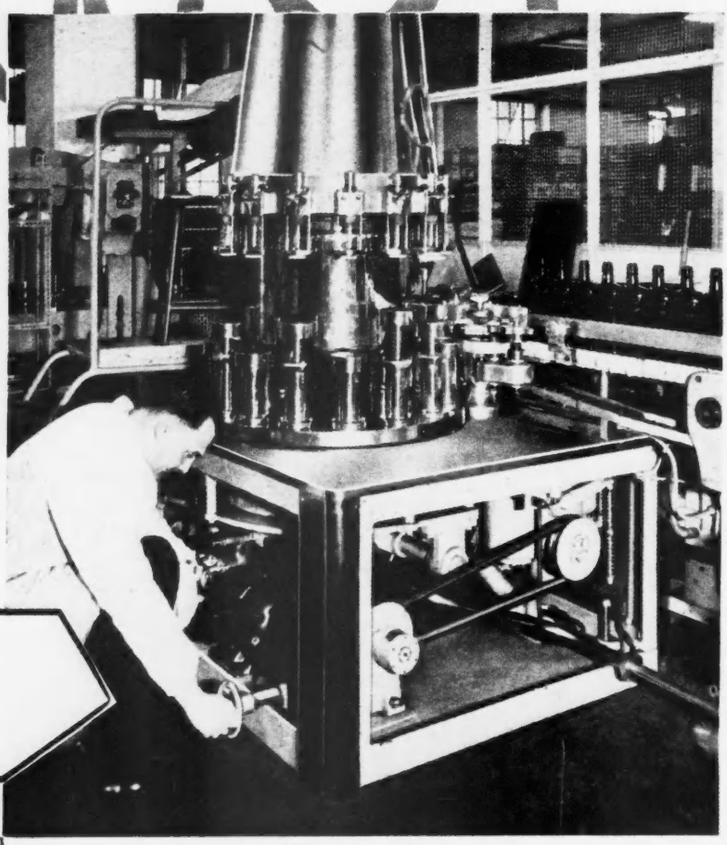

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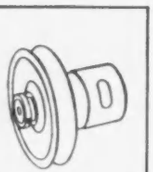

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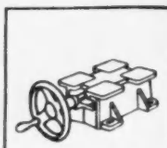

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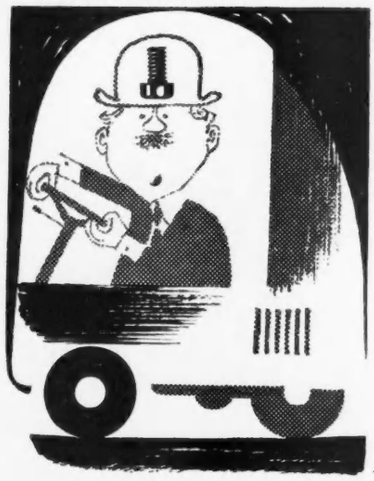

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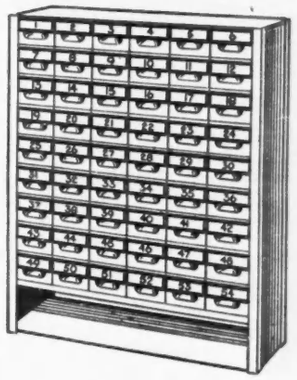

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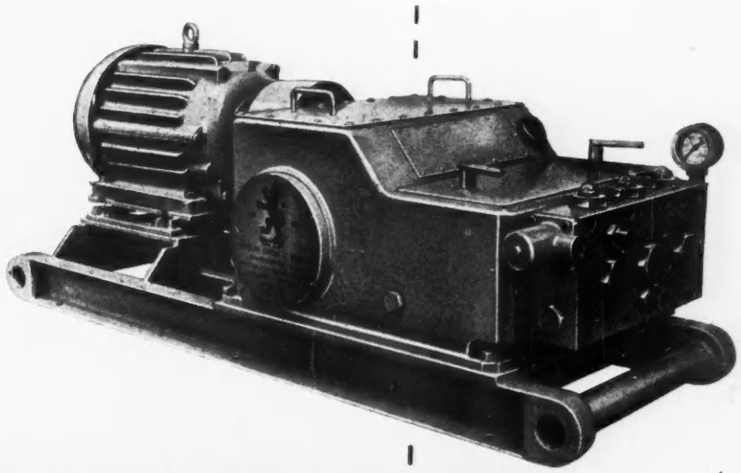

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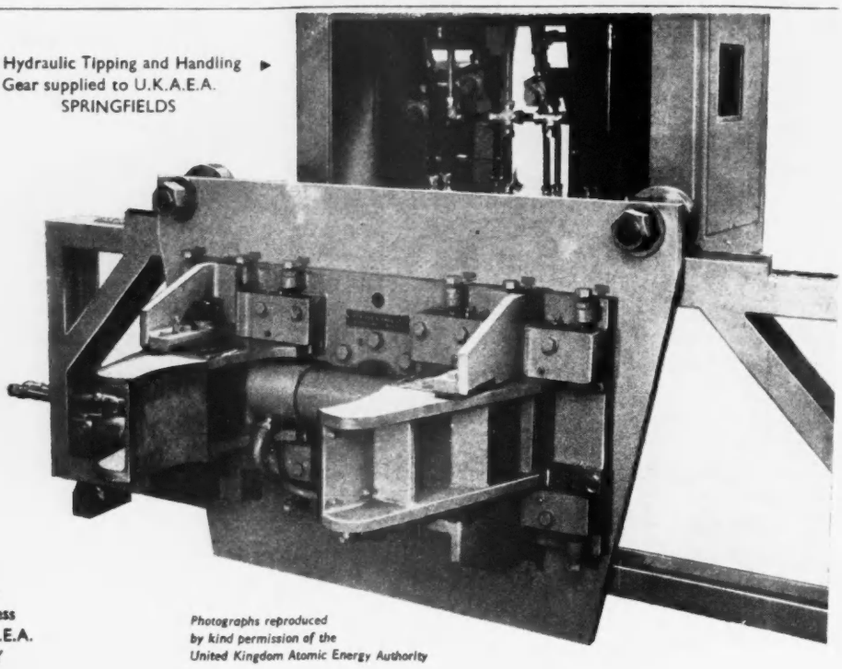

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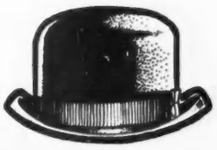

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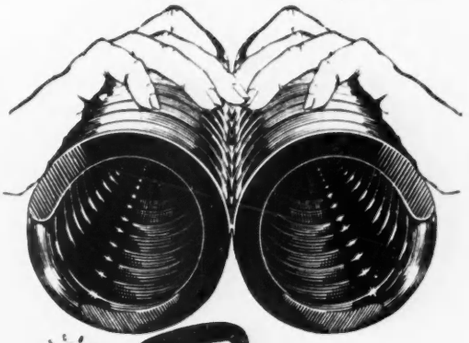

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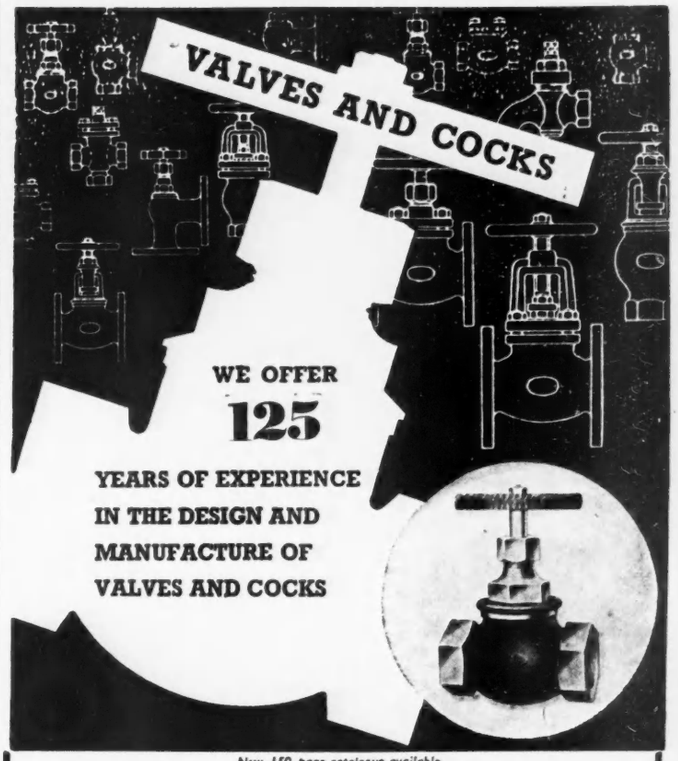

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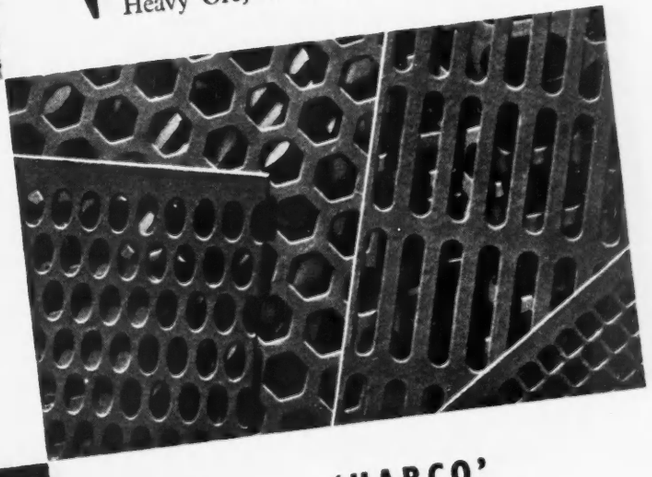

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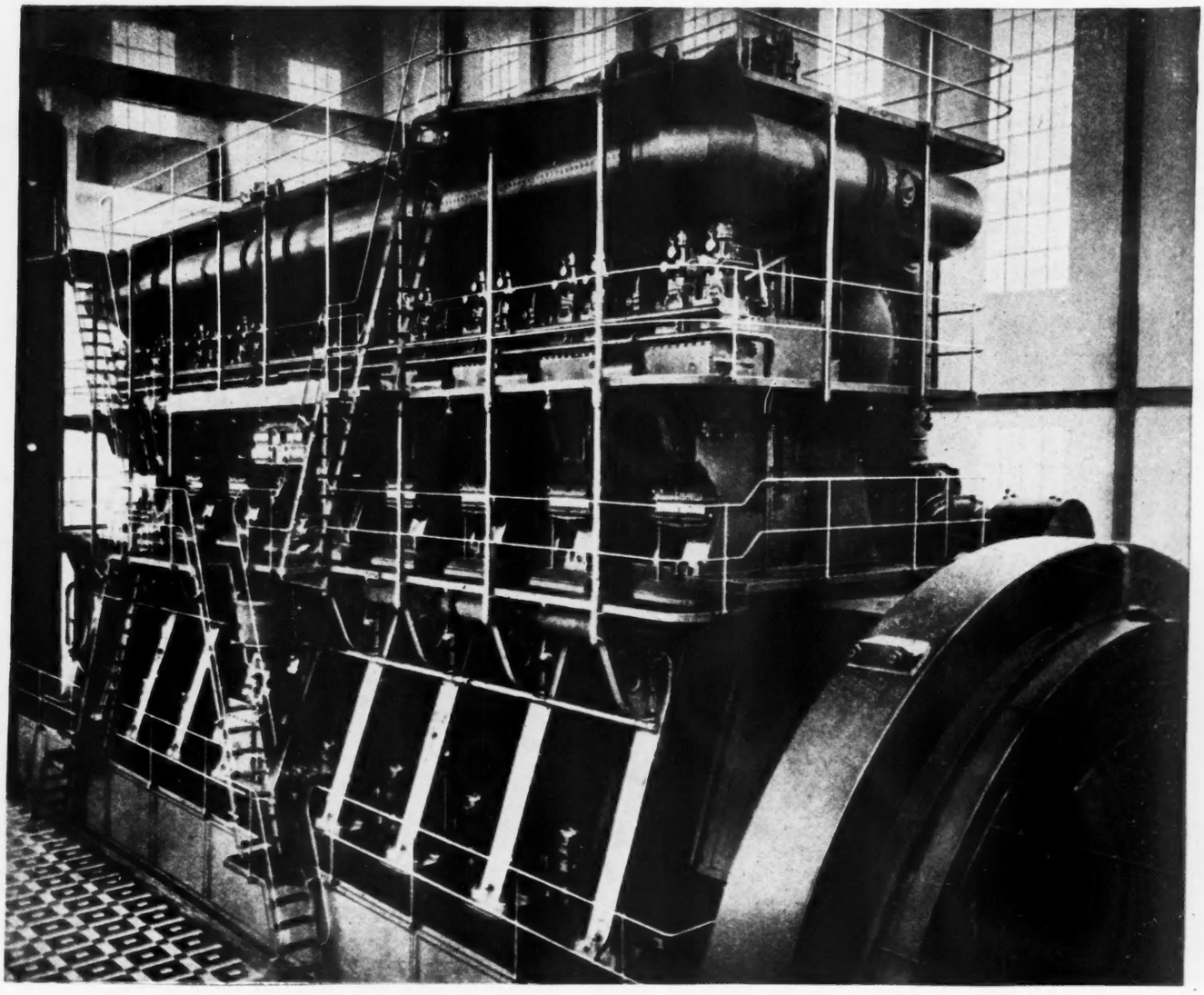

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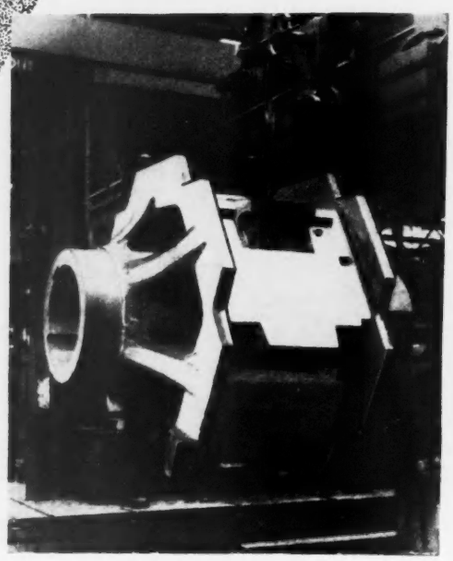

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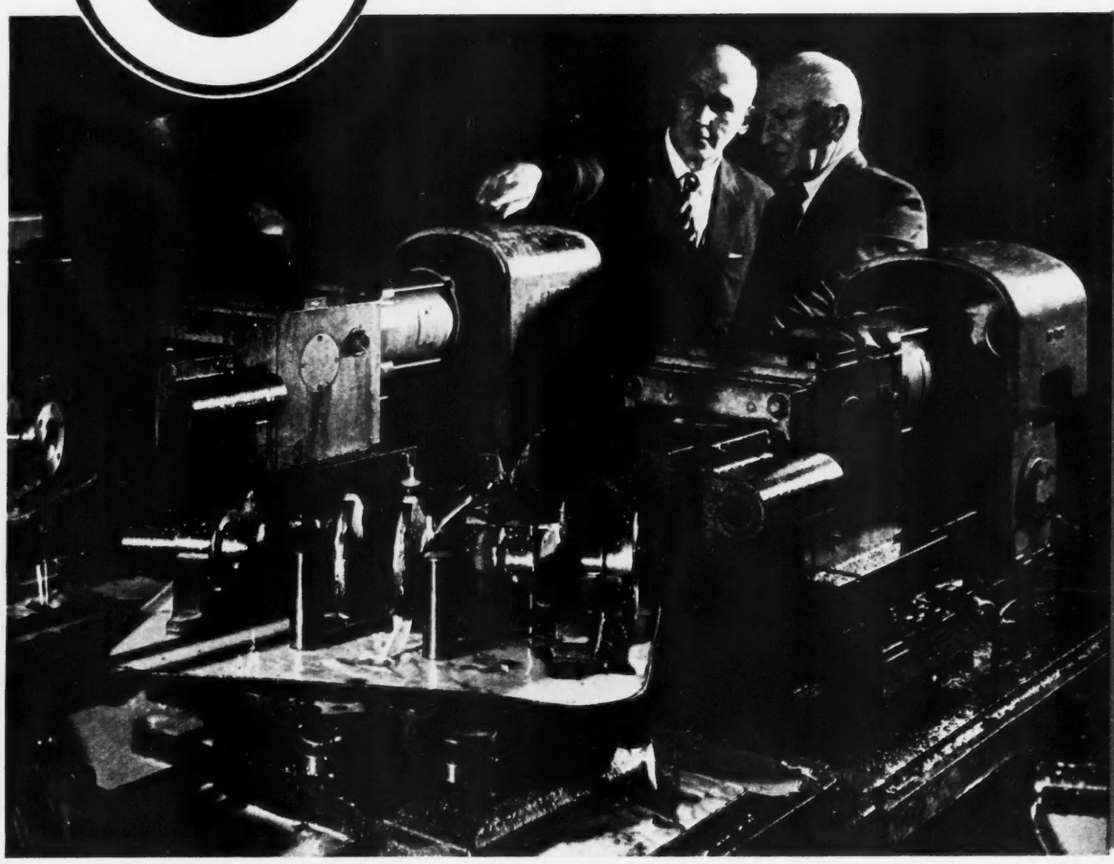

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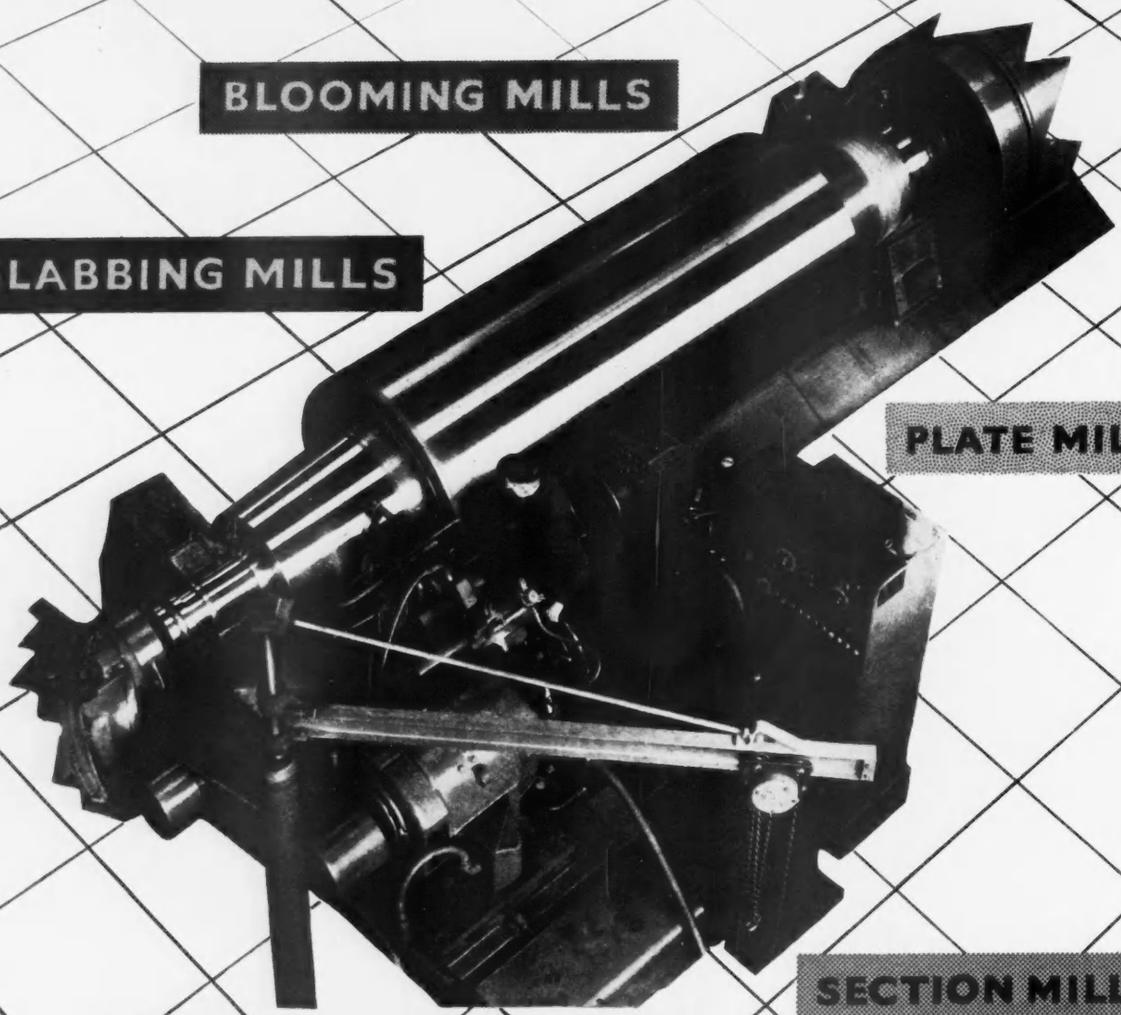

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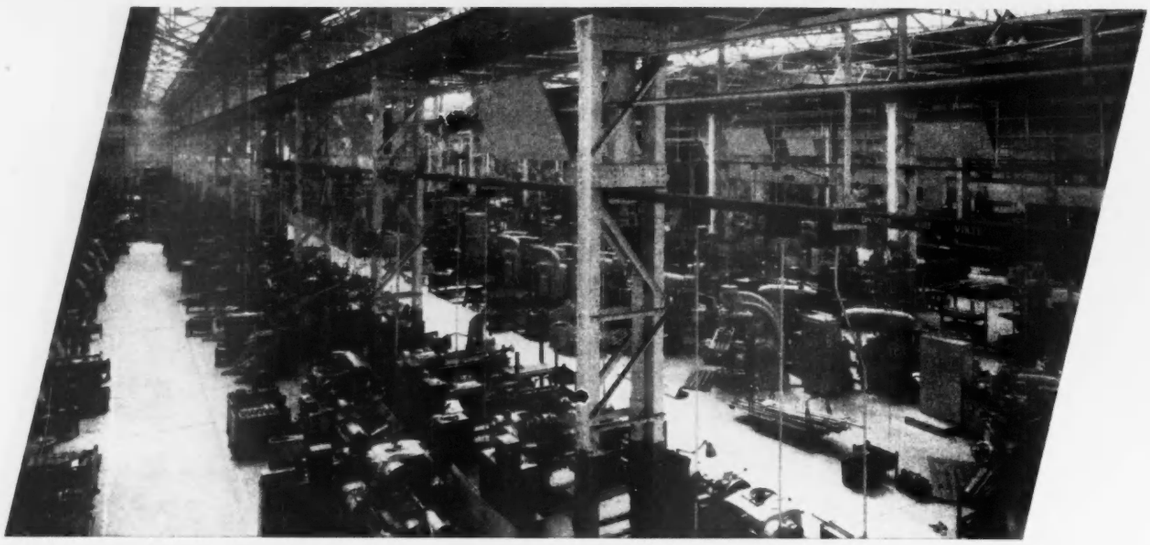

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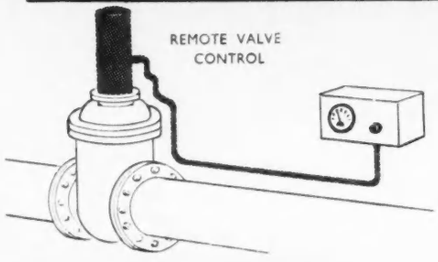

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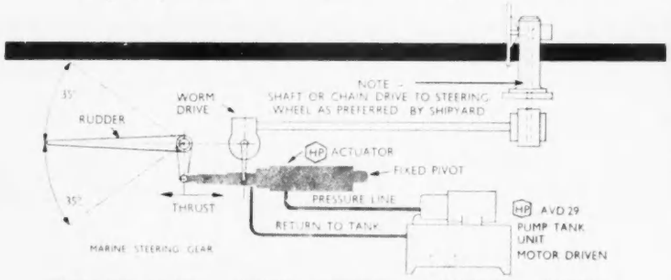

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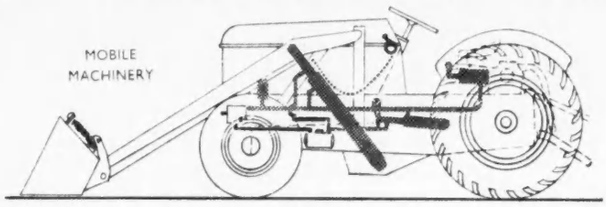

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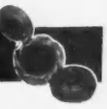

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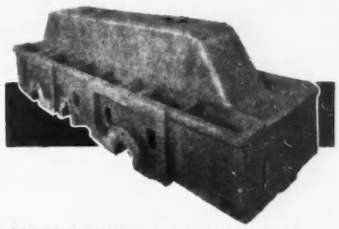

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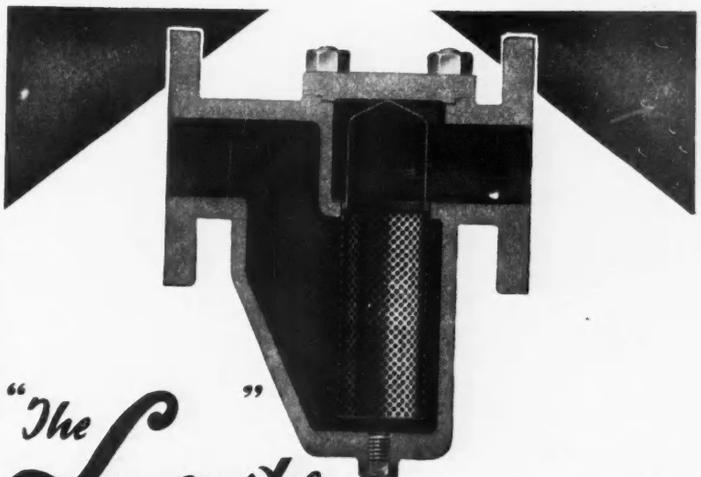

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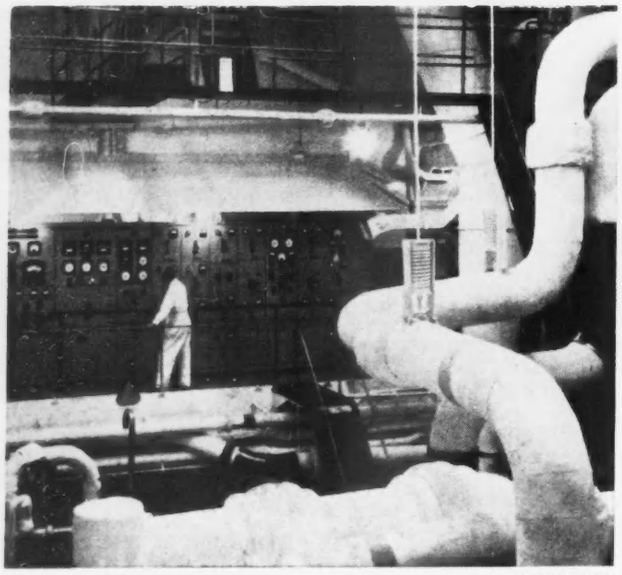

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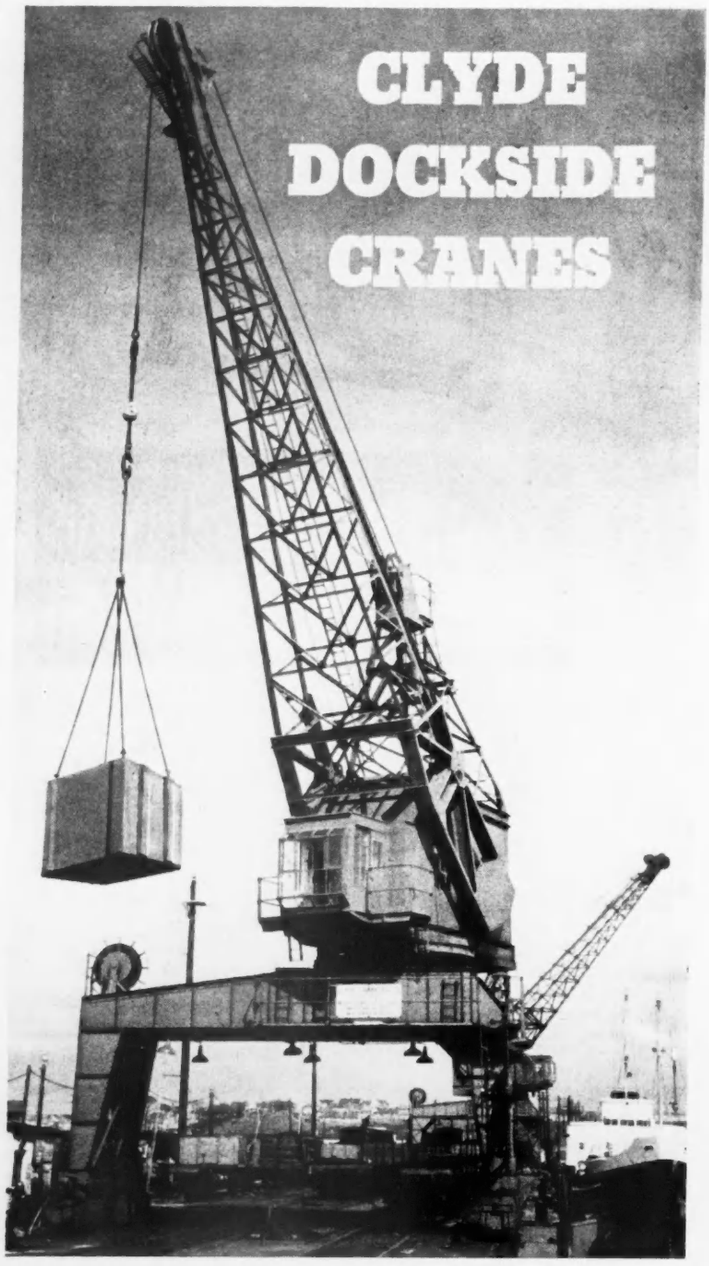

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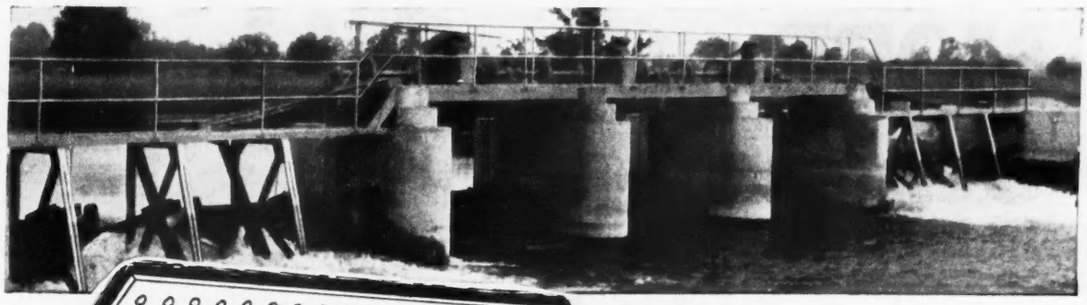

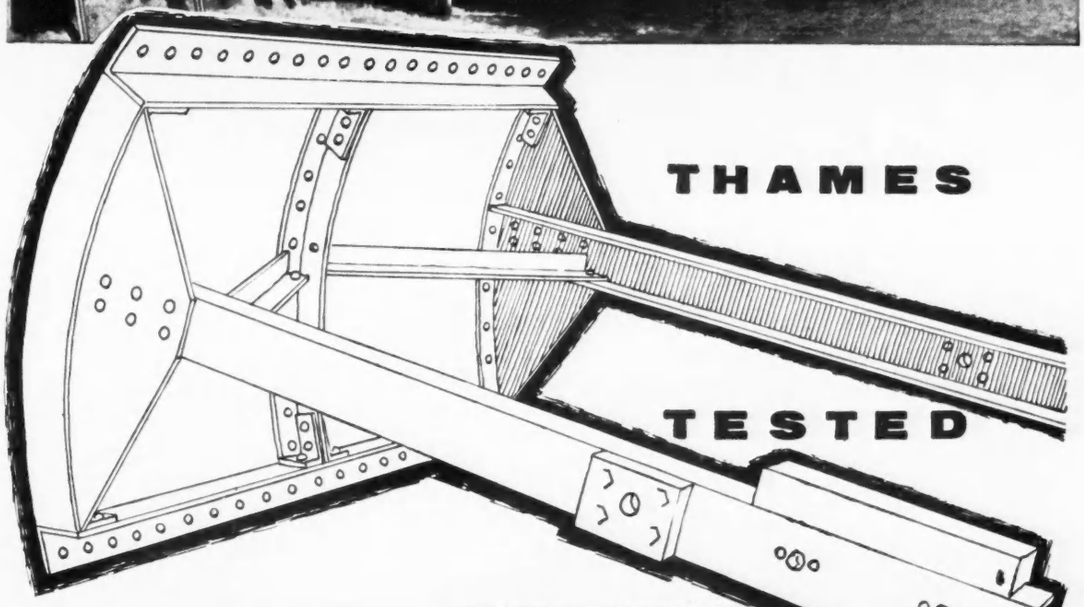

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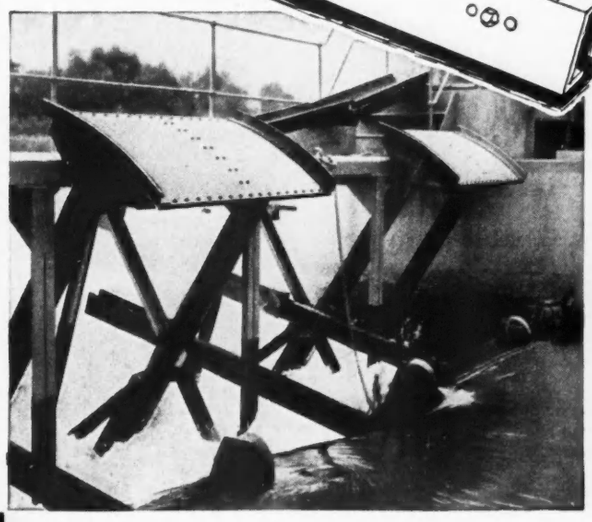

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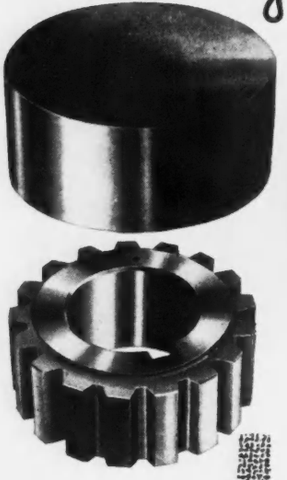

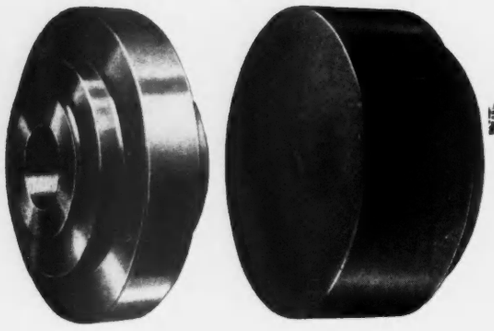

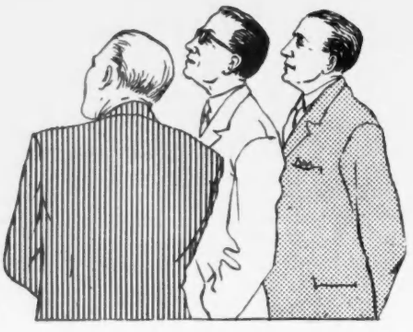

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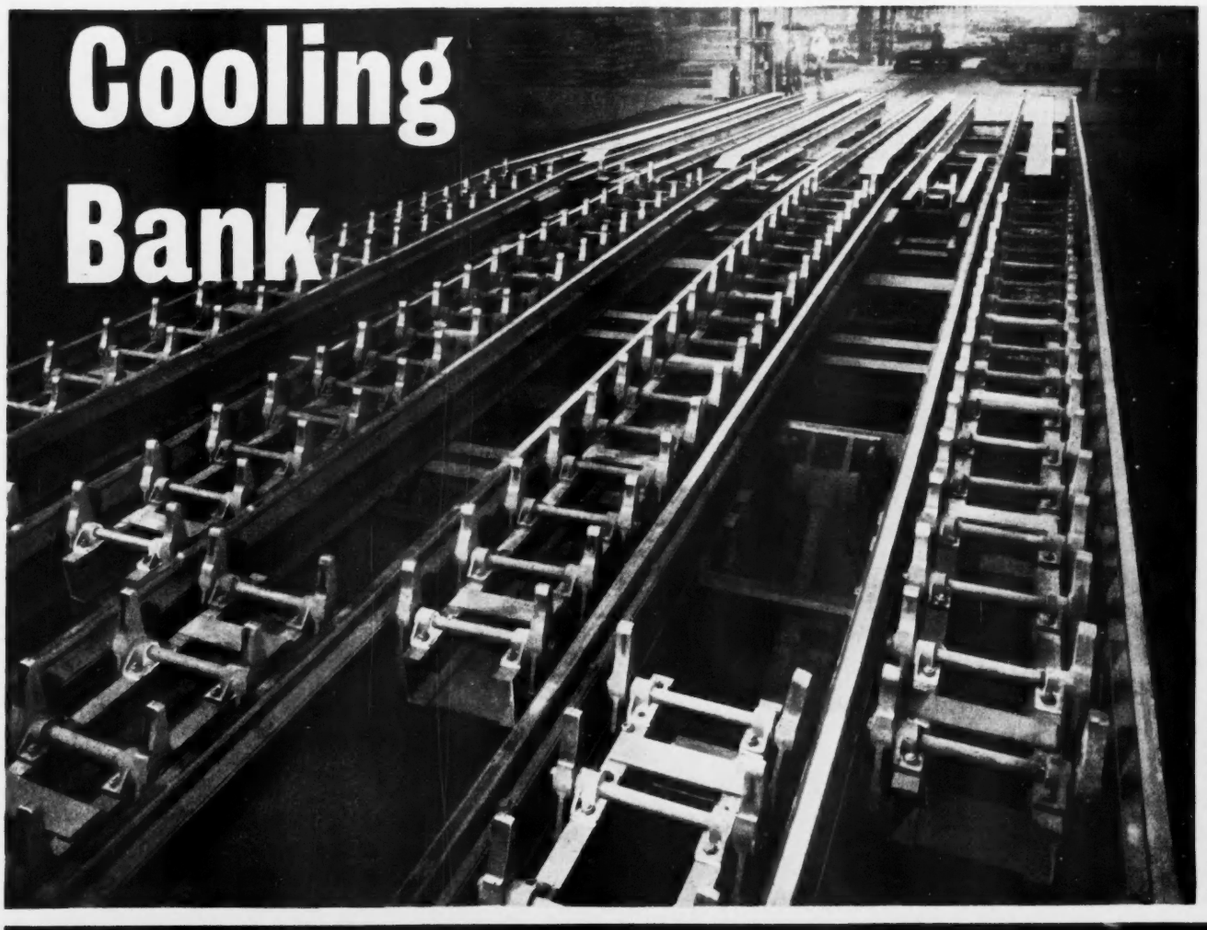

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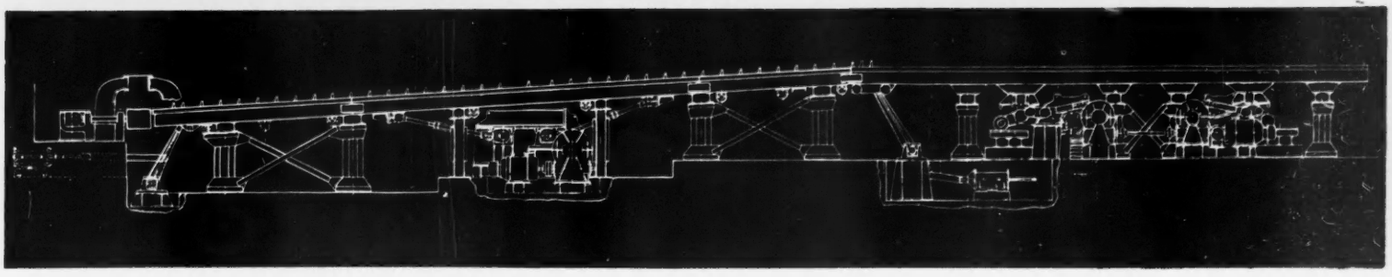

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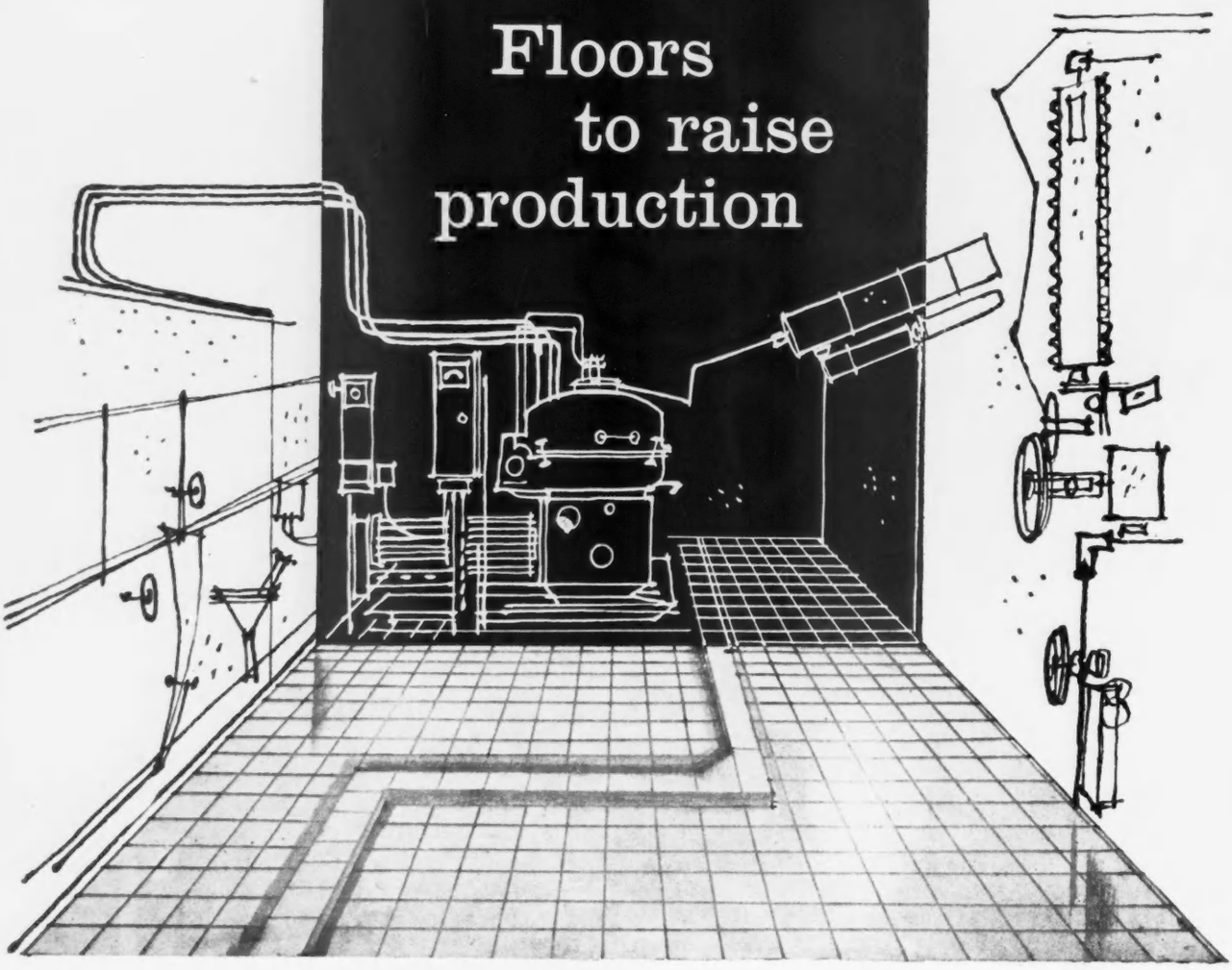
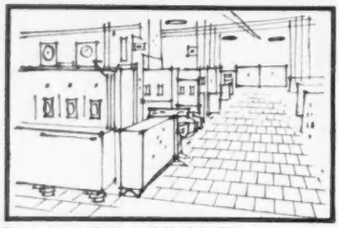
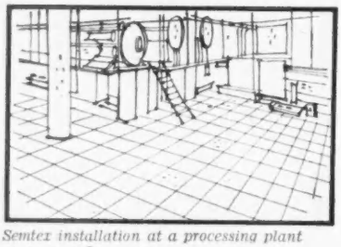




Semtex installation at E.M.I., Hayes.



Semtex installation at a processing plant of the Nestlé Co., Ltd.

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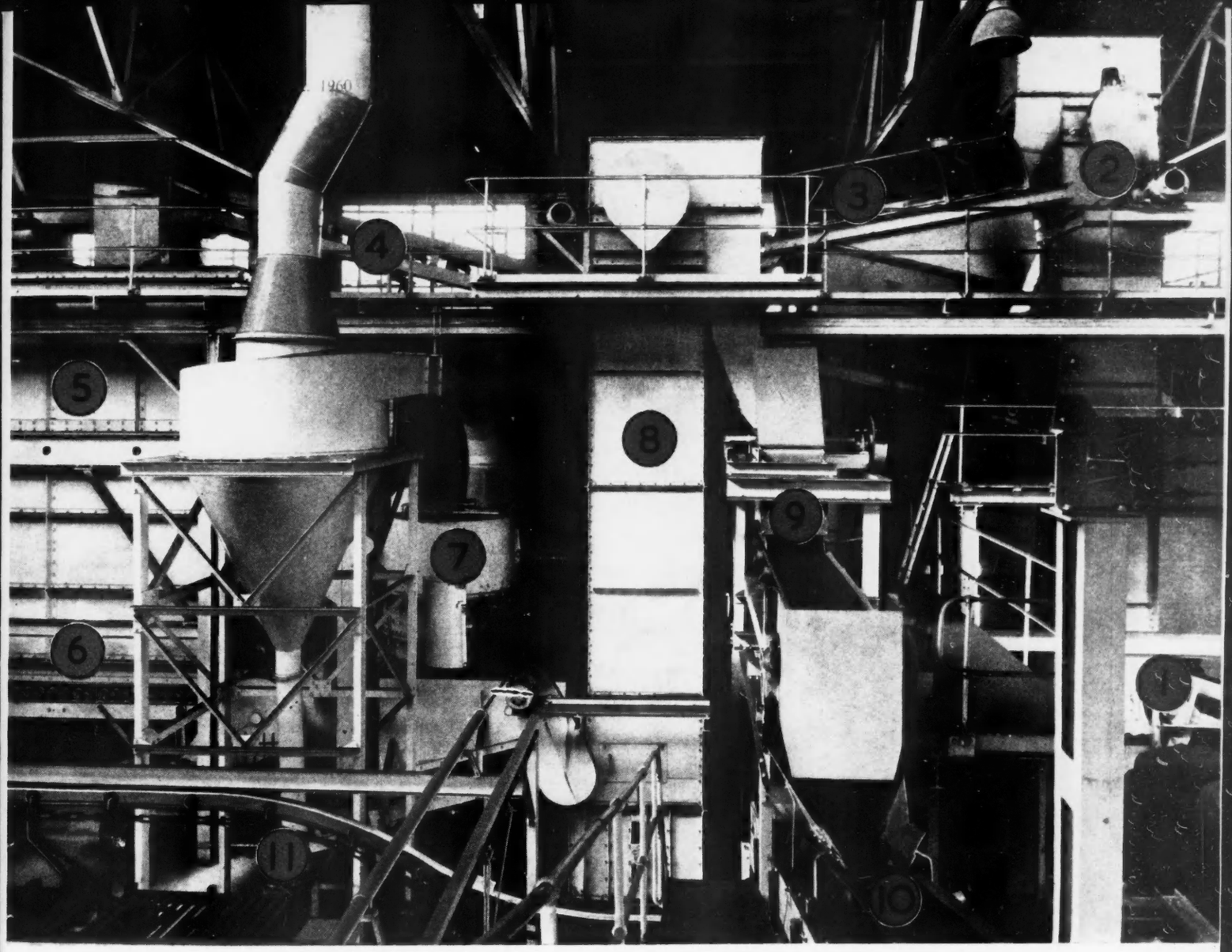

The illustration shows that part of a **MORRIS** foundry sand and mechanization plant which reconditions knocked-out sand. At **1**, sand coming from the knock-out via an apron plate and belt conveyor passes beneath a magnetic separator (to remove tramp iron) and falls into the boot of a belt-bucket elevator **2**, discharging into screen **3** onto belt conveyor **4**, which in turn discharges into sixty-ton storage hopper **5**. The flat belt conveyor **6**, under the hopper, pours sand into the skip which feeds the mulling machine (known as the Speedmullor). This machine **7**, providing a rapid mulling cycle with close batch control, discharges the sand into belt-bucket elevator **8**. From thence, the sand proceeds via belt conveyors **9** and **10** to the moulders. The overhead chain conveyor **11** serves the core shop with sand and also takes the cores to the stoves and to the moulders.

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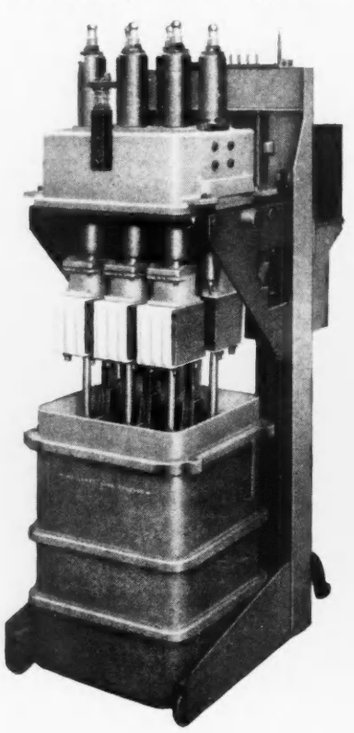

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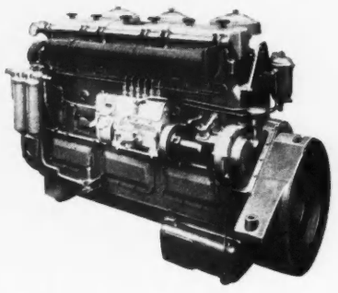
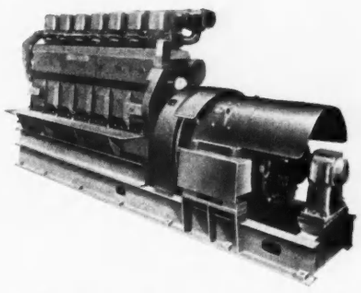


LE6 diesel engine 130/185 b.h.p. at 1200/1800 r.p.m.



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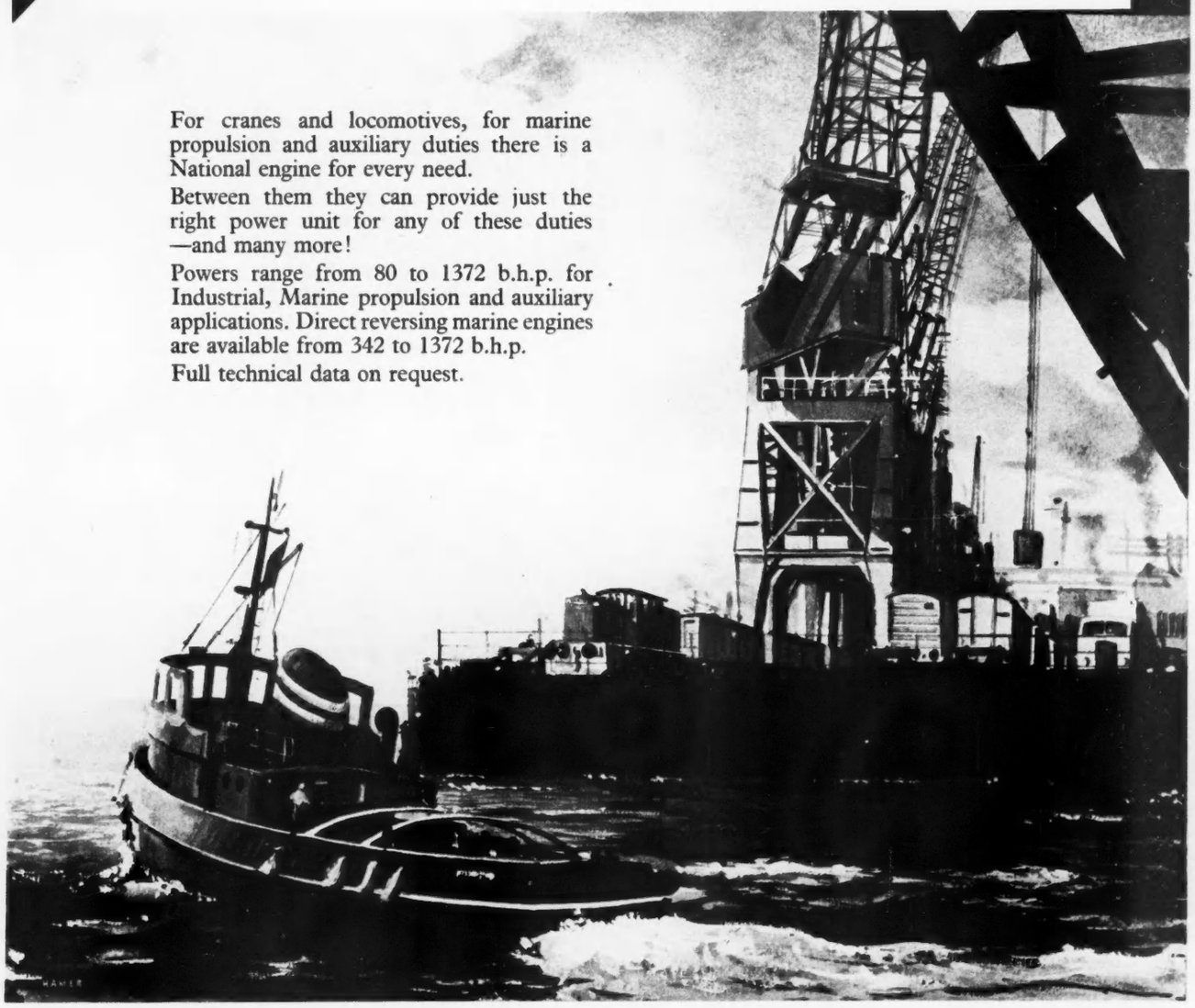

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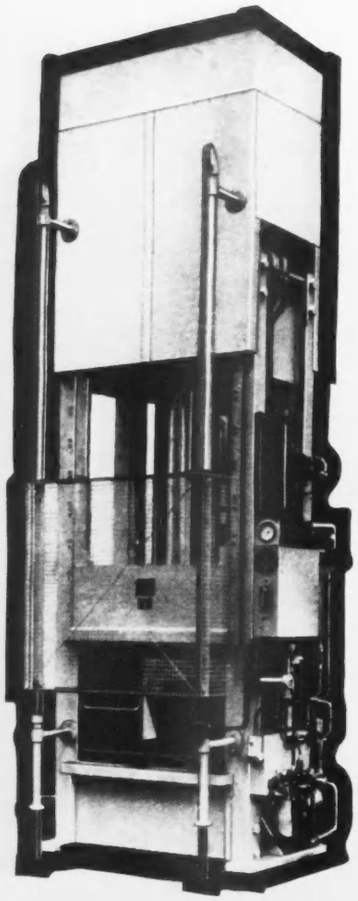

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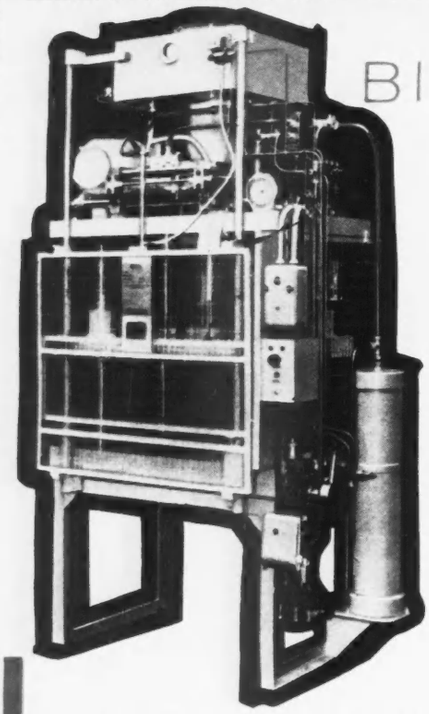

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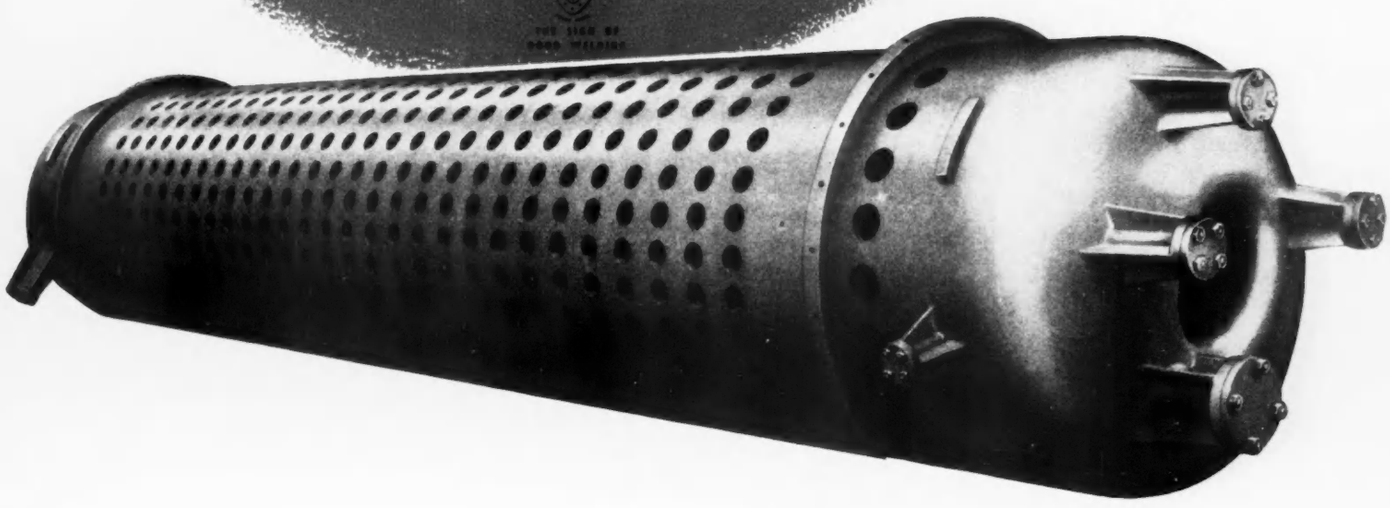

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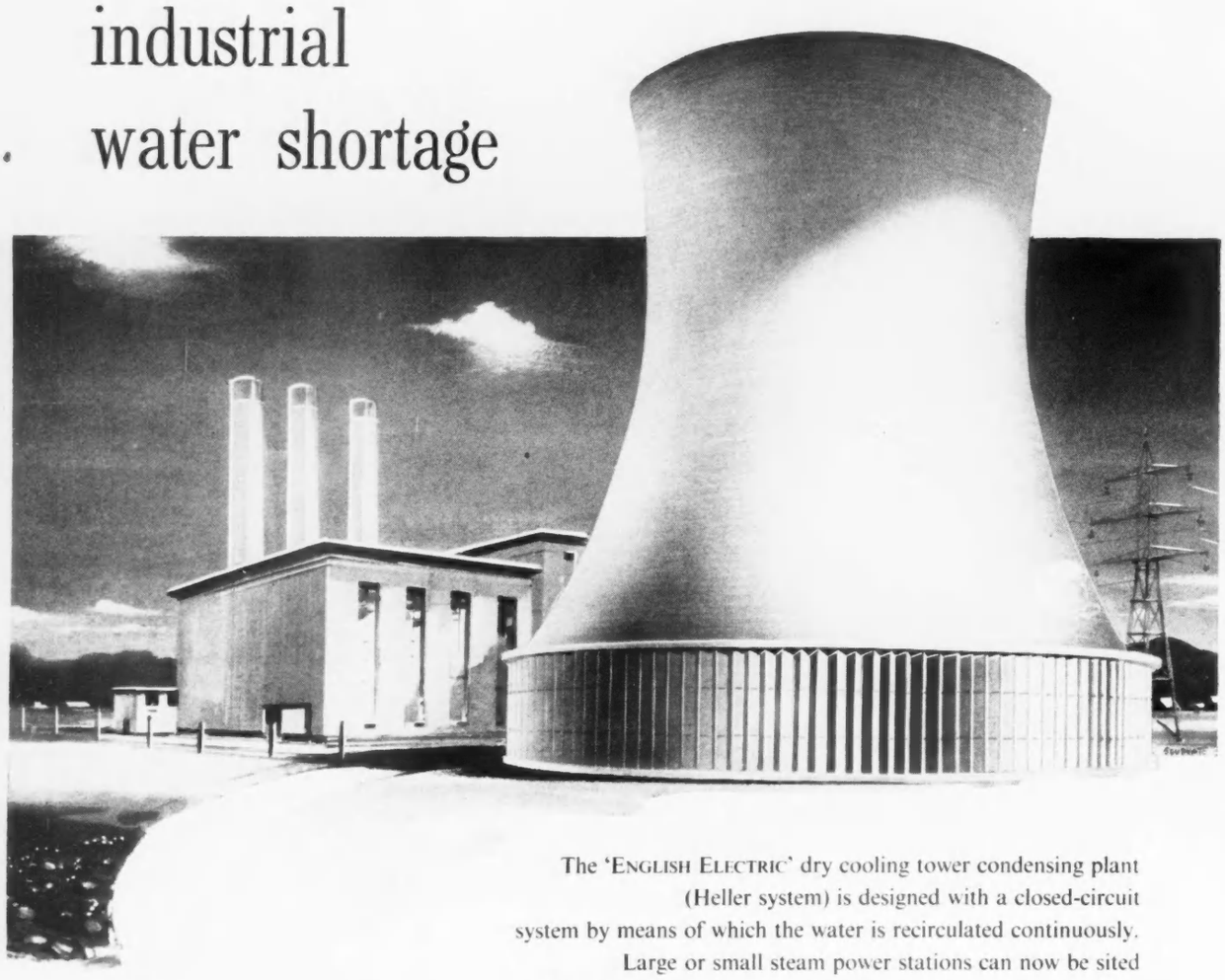

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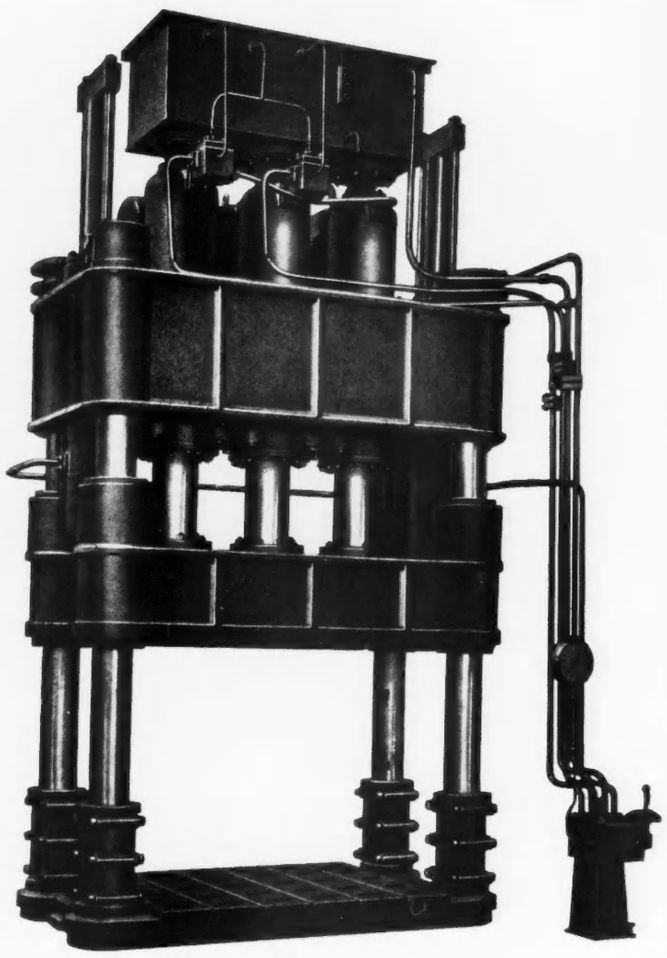

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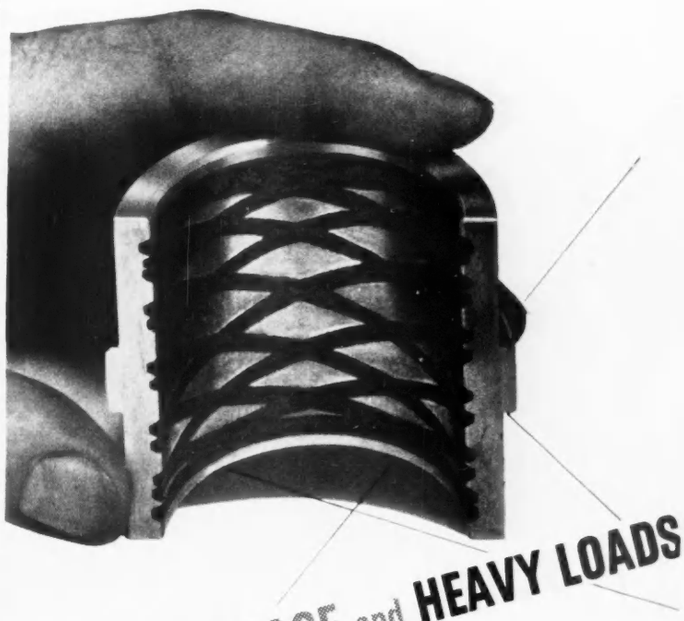

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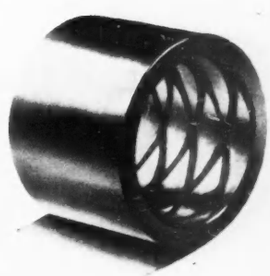

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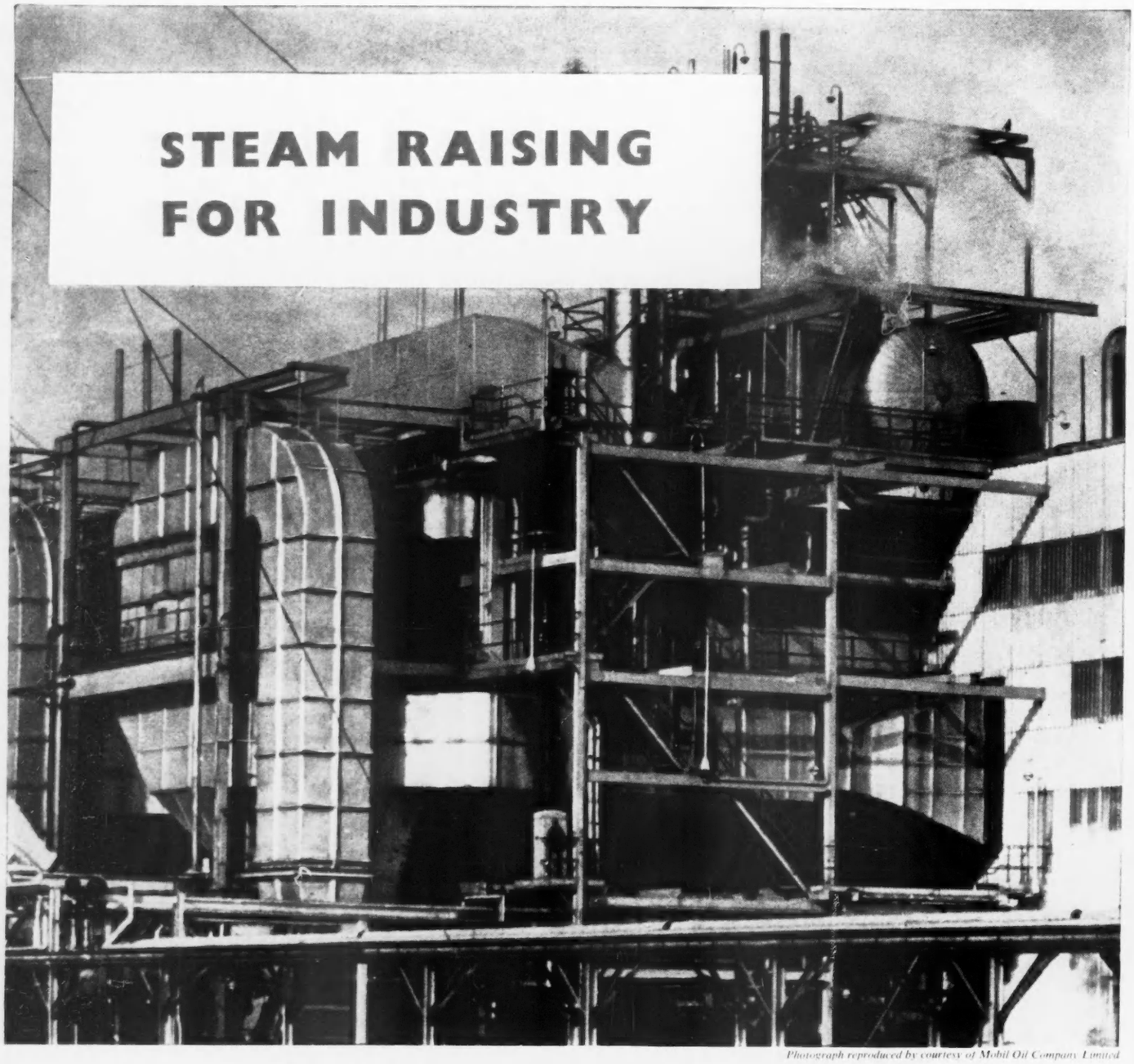

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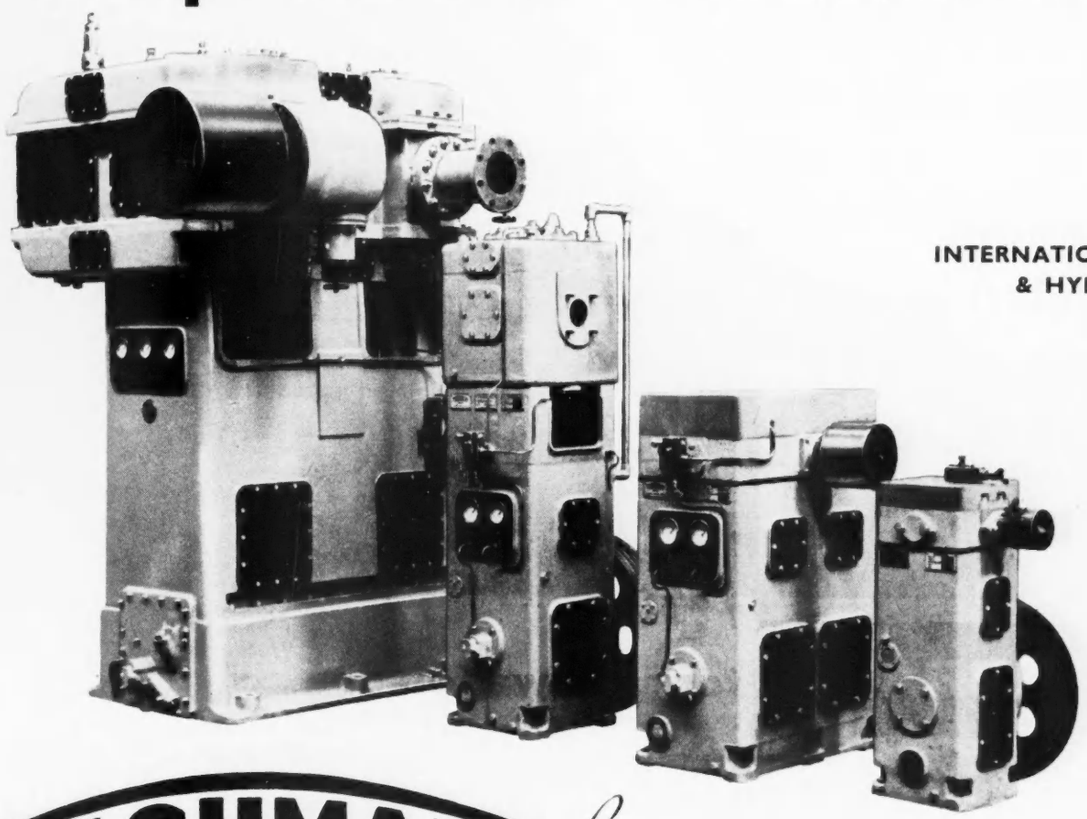

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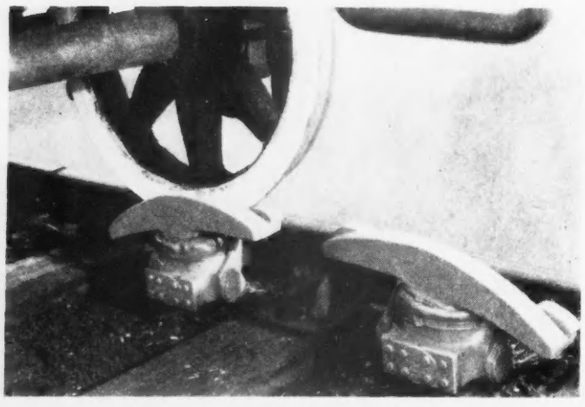

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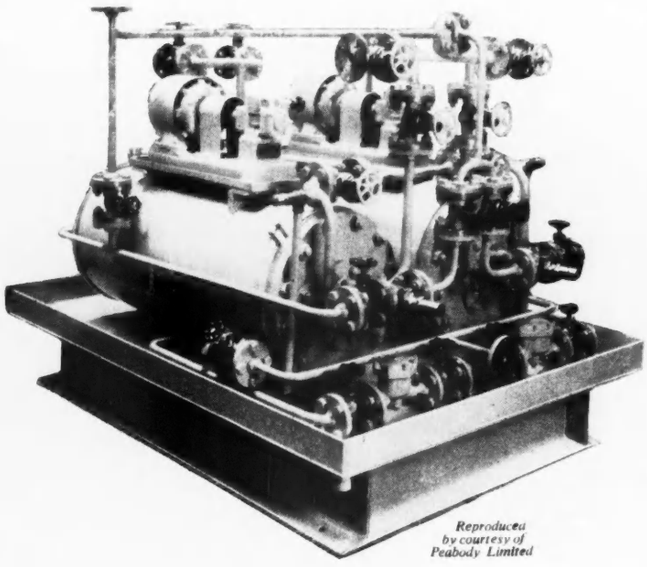

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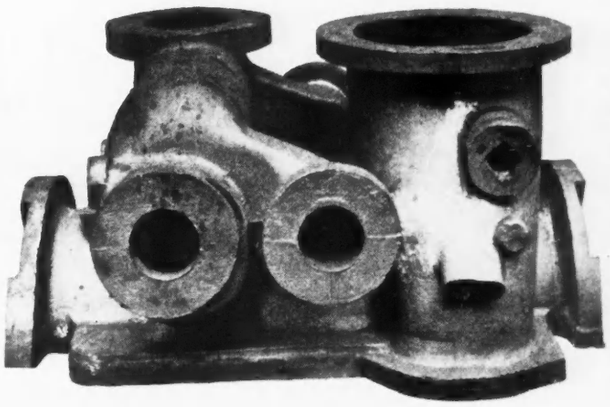

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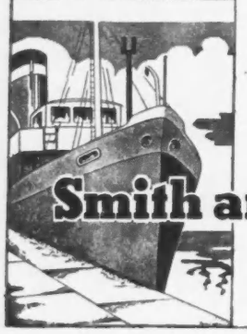

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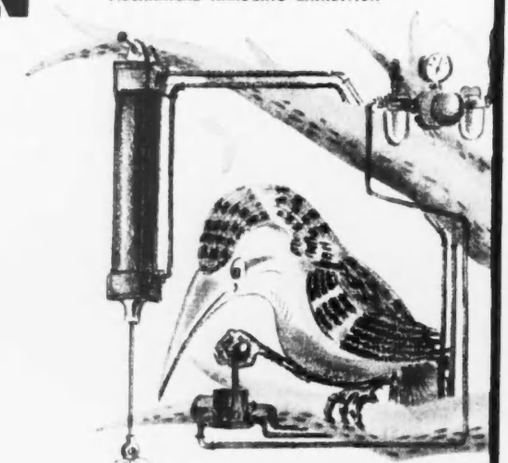

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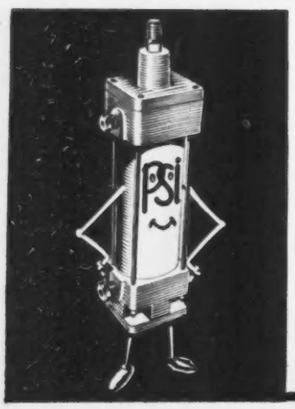

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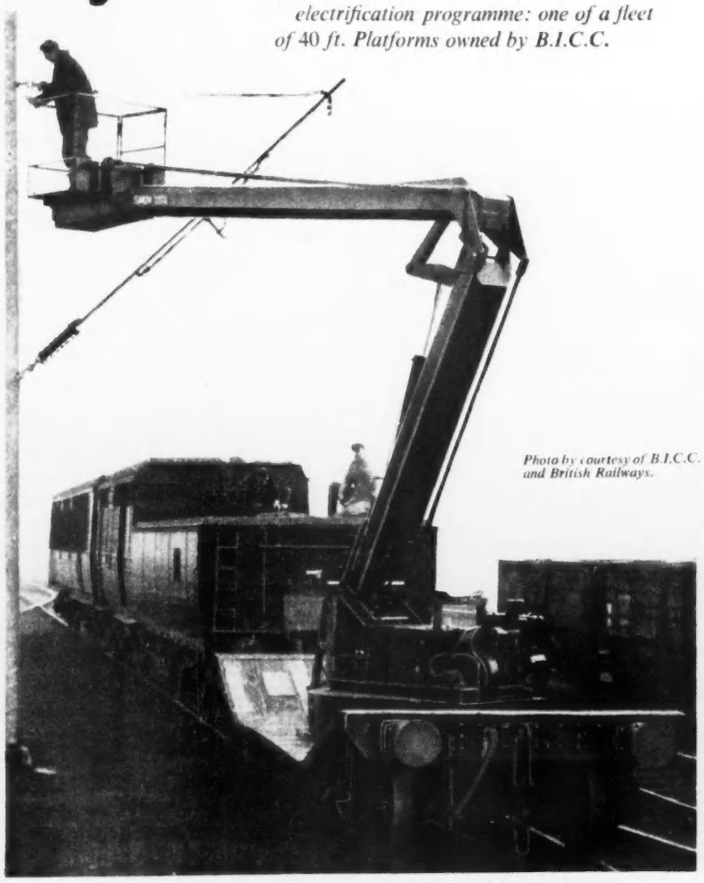

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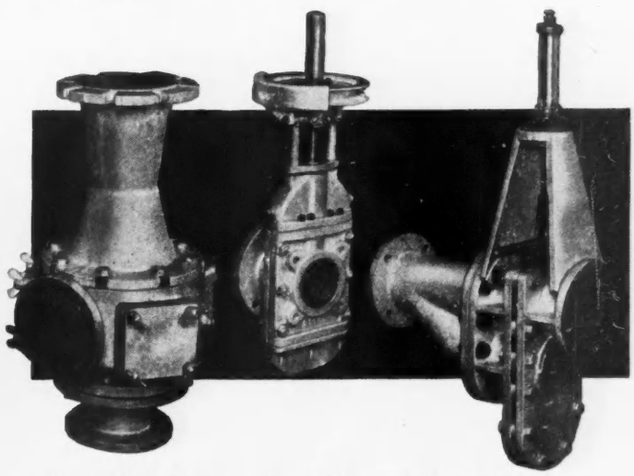

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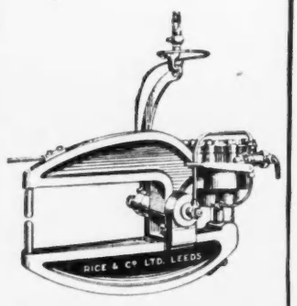

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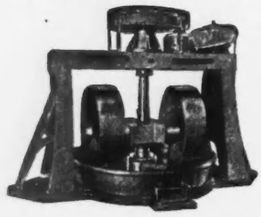

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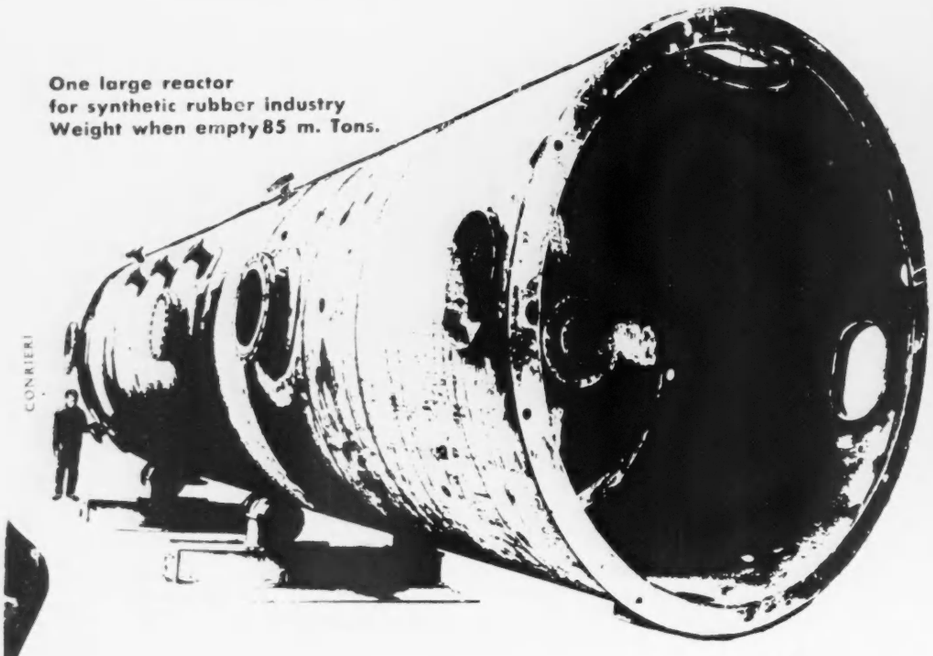

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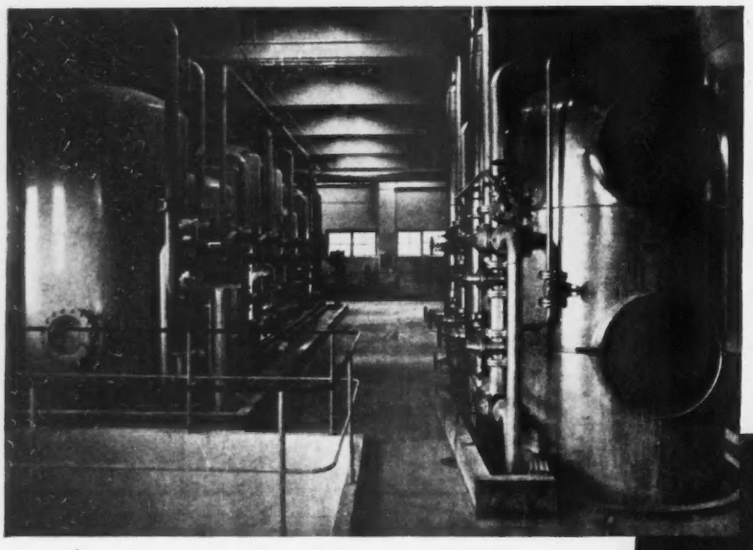

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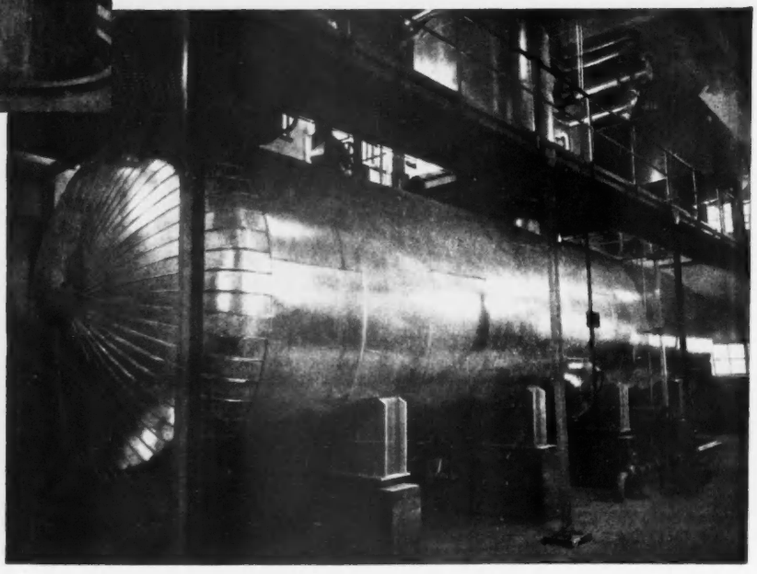

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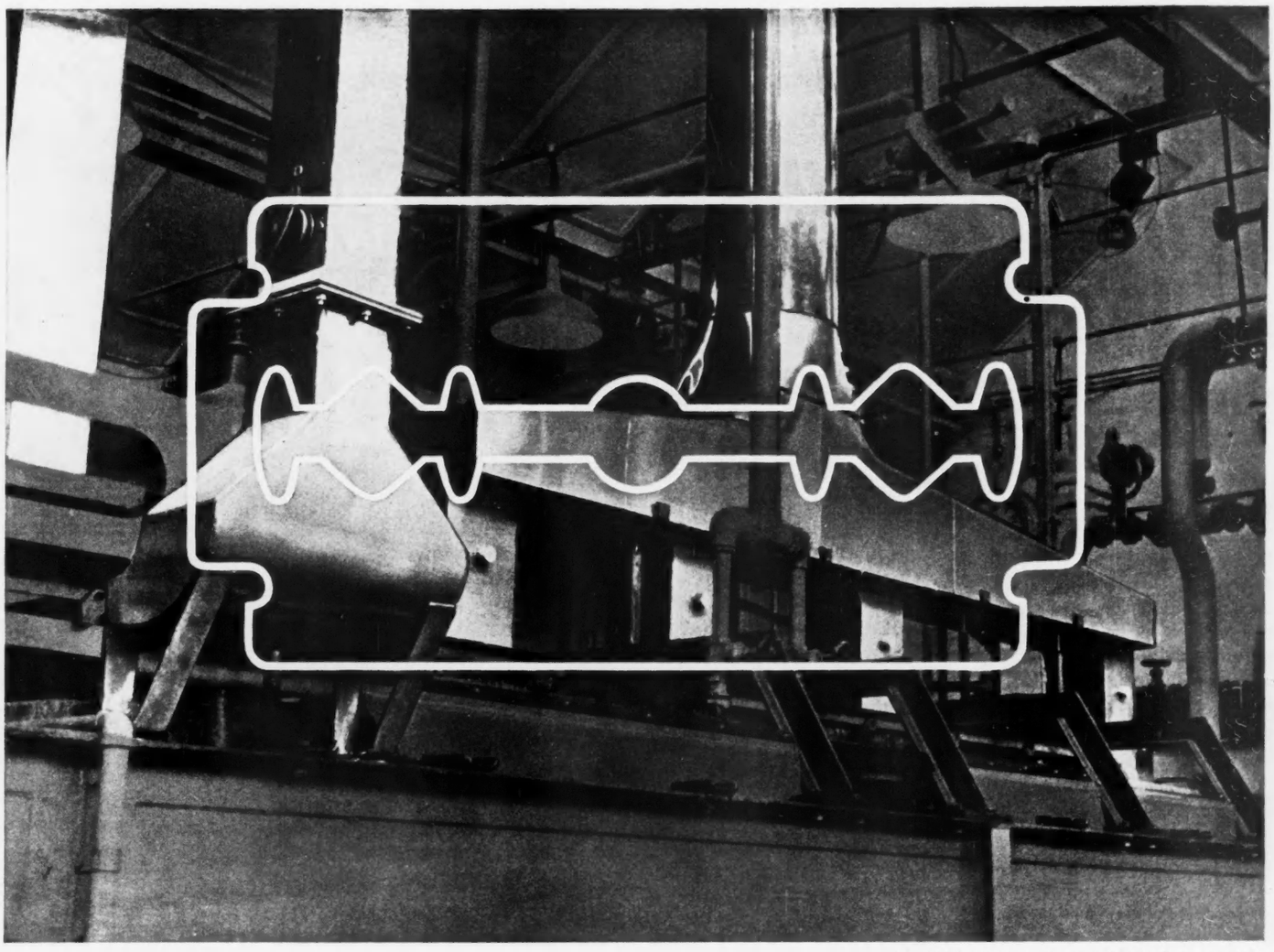

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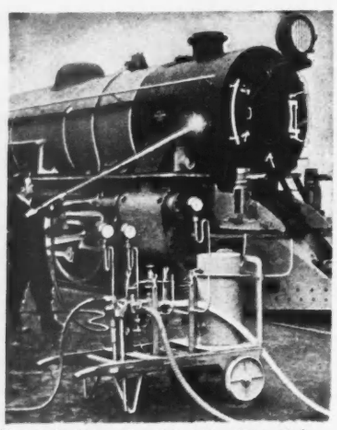

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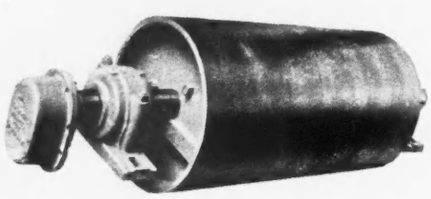

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HUNDREDS of products gain selling advantages when they are made of James Booth aluminium alloys. Why? Because these alloys have virtues which are always in demand. Strength . . . lightness . . . exceptional corrosion resistance . . . workability . . . good electrical properties . . . attractive modern appearance.

Look through your products catalogue. See where improvements can be made with James Booth alloys. If you need advice on the changeover, our technical staff will gladly help. Please write for literature showing the range and uses of our many aluminium alloys.

RECOMPRESSION CHAMBERS

Photo: courtesy SARO (Anglesey) Ltd.

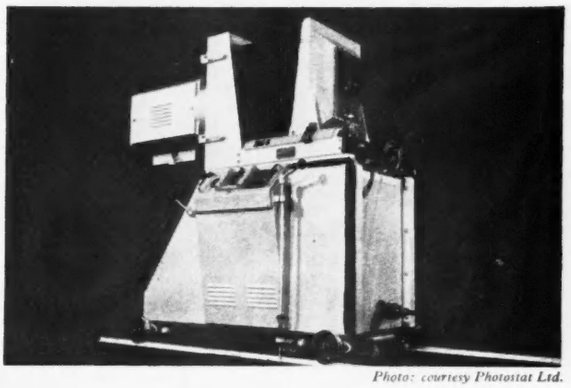
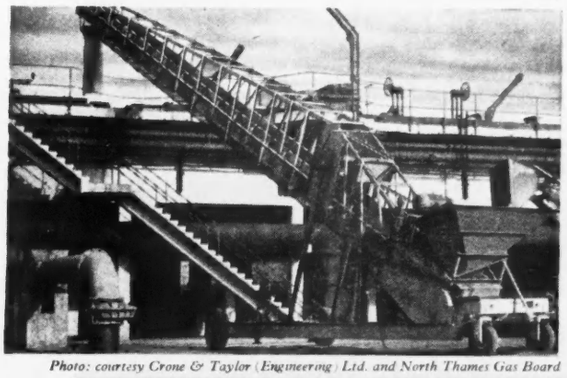


PHOTO-GRAPHIC EQUIPMENT

Photo: courtesy Photostat Ltd.



MOBILE STACKERS

Photo: courtesy Crone & Taylor (Engineering) Ltd. and North Thames Gas Board

GARDEN FURNITURE

Photo: courtesy E. R. Buck & Sons Ltd.

Make more of DURALUMIN

REGD. TRADE MARK

JAMES BOOTH ALUMINIUM LIMITED · KITTS GREEN · BIRMINGHAM 33 · STECHFORD 4020

Extrusions, large forgings, plate, sheet, strip and tubes in light alloys

TQA 1BO 168

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now this 'ere gear 'ere

is made from **ralsin** Nylon 11 . . . and that makes it special. If you'd made the same thing in, let's say steel for instance, it would have needed lubricating for a start all the time—which is just what you wouldn't have to do if you'd made it of RALSIN in the first place. And last; they really do last . . . made of RALSIN. Silent meshing too . . . smeshing!

RALSIN in light engineering provides mouldings and extrusions of great mechanical strength which are dimensionally stable, shock and abrasion resistant and light in weight.

For prototype work, RALSIN can be machined. The material has a high degree of dimensional stability and piece parts produced from RALSIN are capable of being operated continuously at temperatures up to 100°C and down to as low as —64°C.

RALSIN (density 1.04) is the lightest polyamide available commercially. There are many ways in which RALSIN can improve your present products; it can also be instrumental in achieving success—particularly with intricate projects. Whiffens Publication No. R/2/16 will give you all the details you will need about its application and characteristics. Their Technical Service Department will be happy to talk over any particular details of application with you.

WHIFFENS chemicals for industry

A member of the Fisons Group of Companies

Sole agents for RALSIN in the United Kingdom, Commonwealth of Australia and Dominions of New Zealand and Canada.

WHIFFEN AND SONS LIMITED
Willows Works · Derby Road · Loughborough · Leicestershire · Telephone: Loughborough 3141

WS3

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It's NEW . . .

It's NYLON . . .

It's THOREX

"KING OF SOFT HAMMERS"

Made in 5 sizes from 1" to 2" diameter, and ½ lb. to 3 lb. in weight. Price from 10/- to 35/- each. Patented in principal Countries.

The nylon faces, which are turned from a special grade of nylon rod, screw into a machined steel head, and can be fitted or replaced by hand in a few seconds. They are made with a shoulder for increased strength, and serrations to prevent loosening in use. This super quality nylon gives a firm but resilient blow that does not mar the work, is extremely durable, and will not crack nor chip. THOREX is the best "soft" hammer THOR has produced in 25 years, and Works and Production Managers, Buyers and Senior Staff are invited to write for a free test sample and further particulars.

A wide range of THOR Rawhide, Copper, Plastic and Rubber hammers is also available for factory use by toolmakers, metal-workers, mechanics, fitters, assemblers, etc.

THOR HAMMER COMPANY
HIGHLANDS RD., SHIRLEY, BIRMINGHAM
Telephone: SOLihull 4695 (4 lines)

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MICA
ESTABLISHED 1840
FOR
INSULATION
WATER GAUGES
ETC.
F. WIGGINS & SONS
9-11 TREDOWN RD., SYDENHAM, S.E.26
Tel: SYDenham 7660

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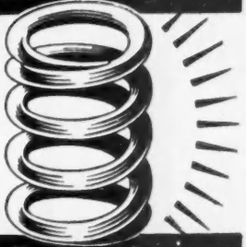
SPRINGS AND SPRING WASHERS
FOR ENGINEERING PURPOSES



Manufactured by
JOHN TONKS & CO LTD.
CENTRAL SPRING WORKS
Furnace Hill, SHEFFIELD, 3
Telephone: SHEFFIELD 24079
Telegrams: TONKS SHEFFIELD 3

Enter No. 1236 on reply card

STEAM · OIL · AIR · GAS · HIGH PRESSURE HOT WATER

VEE-REG
Manufactured by NEWMAN HENDER & CO. LTD.
GLOBE VALVES
are the answer

For
PRESSURES UP TO 900 P.S.I.
TEMPERATURES UP TO 900° F.

A REGULATING STOP VALVE

THE STAINLESS STEEL CLACK AND SEAT GIVE MAXIMUM PROTECTION TO THE VALVE FACES WITH NEGLIGIBLE PRESSURE DROP.

SUITABLE FOR STEAM, GAS, OIL, AIR AND HIGH PRESSURE HOT WATER.

THE PORTED CYLINDER OF THE VALVE CLACK ENSURES AN EXCEPTIONALLY FINE DEGREE OF REGULATION

IMMEDIATE DELIVERIES ARE AVAILABLE FROM ANY OF OUR 9 BRANCHES

THE BRITISH STEAM SPECIALTIES LIMITED
Head Office: FLEET STREET, LEICESTER

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FARRAR BOILERS

FOR ALL INDUSTRIAL PURPOSES
including installations for
GASWORKS · HOTELS
HOSPITALS · SCHOOLS
PITHEAD BATHS
PUBLIC BUILDINGS
GRAIN SILOS Etc.

THE FARRAR BOILERWORKS
NEWARK (NOTTS) ENGLAND
Telegrams: Farrar, Newark 1143
Telephones: Newark 1143-4-5

RAISE STEAM WITH A "FARRAR"

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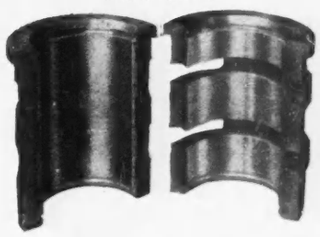
BEARING RECONDITIONING
ANY SIZE UP TO 12" SHAFT DIAMETER



Wheatley & Whiteley
99, Kirkstall Rd., Leeds, 3 Tel. 31122

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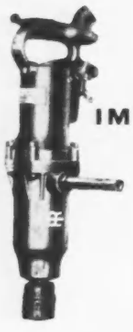
Ingersoll-Rand

air powered hand tools for industry



IMPACTOOLS

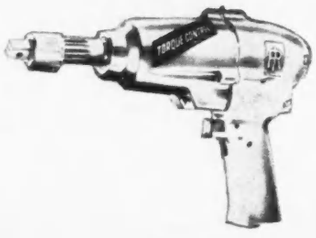
SCALING HAMMERS

SMALL MULTI-VANE DRILLS

P.3781

SAND RAMMERS

TORQUE CONTROL IMPACTOOLS



Ingersoll-Rand hand-held power tools are made and designed specifically for the following industries. Please tick the industry with which you are concerned. Descriptive literature will be mailed to you by return.

- Oil & Petroleum ☐
- Iron and Steel ☐
- Fabricated Metals ☐
- Automobile ☐
- Aircraft ☐
- Railway ☐
- Ship and Boat Building ☐
- Machinery (Mechanical) ☐
- Machinery (Electrical) ☐
- Mining ☐
- Public Utilities (Electricity, Gas, Water, Telephone, etc.) ☐

NAME .....

COMPANY .....

ADDRESS .....

Power in hand with—

Ingersoll-Rand

INGERSOLL-RAND COMPANY LIMITED

165 QUEEN VICTORIA STREET LONDON EC4 · TEL: CEN 5681

SCOTTISH OFFICE: 20 RENFREW STREET GLASGOW C2

TEL: DOUGLAS 1233 · GRAMS: INGERSOLL GLASGOW

P.3870

Enter No. 1241 on reply card

CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. **Minimum 18/-.** **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. **Minimum 16/-.** **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING OF UNIVERSITY COLLEGE, IBADAN, AT NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY

SENIOR LECTURESHIPS OR LECTURESHIPS

Applications are invited for SENIOR LECTURESHIPS OR LECTURESHIPS in :

Civil Engineering
Mechanical Engineering
Electrical Engineering

in the Department of Engineering, which has been recognised as the Faculty of Engineering of University College, Ibadan, in Special Relation with the University of London.

Salary scales (Contract) including 20 per cent contract addition and inducement addition of £240 to £300 p.a., payable to overseas officers only.

Senior Lecturer : £2475 by £90 to £2745 p.a.

Lecturer : £1500 by £75 to £2400 p.a.

Gratuity at £150 p.a. Free first class passages (up to a maximum of four adult passages) on appointment, termination and annual leave in U.K. Part-furnished quarters at low rental. Children's U.K. maintenance and other allowances. Appointments normally on contract for two sessions in first instance and renewable.

Pensionable appointments with consequently lower salary and without gratuity may be available in certain circumstances.

Detailed applications (6 copies), naming 3 referees to Secretary, Inter-University Council for Higher Education Overseas, 29, Woburn Square, London, W.C.1, from whom further particulars may be obtained. E9537

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE, GLADSTONE ROAD, S.W.19

GRADE B ASSISTANT

GRADE B ASSISTANT required September, mainly to teach ENGINEERING DRAWING in Ordinary National and Machine Shop Engineering Courses. Preference to candidates with good Drawing Office experience and knowledge of Workshop Technology, who are corporate members of Institution of Mechanical Engineers. Salary, Burnham Technical Scale, plus London Allowance.

Application form and further particulars obtainable from Principal, to be returned by 6th May, 1960. E9558

UNIVERSITY OF LIVERPOOL

APPOINTMENTS

Applications are invited for the following posts in the Department of Civil Engineering :

TWO POSTS OF LECTURER : The initial salary will be within the range £900 to £1650 per annum, according to age, qualifications and experience.

DEMONSTRATOR : The initial salary will be within the range £600 to £650 per annum, according to age, qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, quoting reference CV/En, should be received not later than 28th May, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E9548

UNIVERSITY OF MELBOURNE

SENIOR LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the above-mentioned position.

The salary range is £A2200 to £A2600 per annum. Commencing salary will be fixed according to qualifications and experience. Superannuation similar to F.S.S.U. in Great Britain will be provided.

Further particulars may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 31st May, 1960. E9556

PUBLIC APPOINTMENTS

WARWICKSHIRE EDUCATION COMMITTEE

MID-WARWICKSHIRE COLLEGE OF FURTHER EDUCATION, WARWICK NEW ROAD, LEAMINGTON SPA

Principal : H. M. MARKLEW, M.Sc., A.M.I.E.E.

ENGINEERING DEPARTMENT

Applications are invited for the following full-time appointments, duties to commence on September 1st, 1960.

SENIOR LECTURER.—Candidates must have Graduate or equivalent qualifications, good industrial experience, and lecturing experience at H.N.C. or post-H.N.C. level in either MECHANICAL OR PRODUCTION ENGINEERING subjects. Experience in Management Subjects or Metrology may be of advantage. The post will involve a substantial share in departmental administration.

LECTURER IN MATHEMATICS to H.N.C. level.—Candidates should have Graduate qualifications and extensive experience in teaching of Mathematics to technical students. Ability to take Physics to G.C.E. "A" level and responsible experience in these subjects through a range of courses would be advantages.

LECTURER IN PRODUCTION ENGINEERING, to take Workshop Technology and associated subjects including Workshop Practice, to H.N.C. and Final C.G.L.I. level. Candidates should have post-H.N.C. qualifications and good industrial experience. A sound knowledge of machine tools and processes, and ability to take high level practical work is required.

Grade "B" ASSISTANT, to take ELECTRICAL INSTALLATIONS subject to at least C.G.L.I. "B" Certificate level. Candidates must be adequately qualified and have good industrial experience, and must be able to deal with practical installation work. Ability to offer ancillary subjects, or additional mechanical craft subjects, would be an advantage.

Grade "B" ASSISTANT, to take AGRICULTURAL ENGINEERING for C.G.L.I. courses 260 and 261. Candidates should have Engineering or Agricultural Engineering qualifications and wide experience in the repair and overhaul of tractors and Agricultural machinery, including the setting of equipment in the field. A sound knowledge of workshop processes, including welding, is required.

Salary in accordance with the Burnham Technical Report, viz., Senior Lecturer £1550 by £50 to £1750 per annum ; Lecturer, £1370 by £35 to £1550 per annum ; Grade "B," £700 by £27 10s. to £1150 per annum. In the latter case, suitable additions to minimum will be made for appropriate industrial or teaching experience, or qualifications.

Application forms and further details are obtainable from the Principal and should be returned within two weeks of the appearance of the advertisement.

N. A. Y. YORKE-LODGE,
County Education Officer.

E9577

UNIVERSITY OF MALAYA IN KUALA LUMPUR

LECTURESHIPS OR ASSISTANT LECTURESHIPS IN ENGINEERING

Applications are invited for appointment to LECTURESHIPS or ASSISTANT LECTURESHIPS IN ENGINEERING, depending on the qualifications and experience of the successful candidates. The appointees will be expected to assume duty as early as possible. Special attention will by given in considering one of the appointments to candidates competent to conduct courses in Metallurgy to degree level. Candidates must be University graduates in Engineering and hold recognised professional qualifications.

The salary scale for a Lecturer is £1148 by £49—£1442/£1540 by £56—£1820, and for an Assistant Lecturer £1001 by £49 to £1099. In addition a variable allowance is at present paid at 35 per cent of basic salary subject to certain maxima, together with expatriation allowance at specified rates.

First class sea passages are provided for the appointee and his family ; a furnished house or flat is also provided at a reasonable rental.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close, in Malaya and London, on 30th May, 1960. E9557

PUBLIC APPOINTMENTS

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE

Principal : E. BAILEY, B.Sc., F.R.I.C. A.M.I.Chem.E.

SENIOR LECTURER IN CIVIL ENGINEERING

Required in September, 1960, for additional courses in the College.

SENIOR LECTURER IN CIVIL ENGINEERING, to teach to Degree and H.N.C. (Civil Engineering) levels in one or more of Structural Analysis, Design of Reinforced Concrete and Structural Steel Work, Soil Mechanics. Candidates should be Chartered Civil Engineers and hold an Engineering Degree and have had good industrial experience and preferably teaching experience.

Salary : Burnham Technical Report.

Senior Lecturer : £1550 by £50 to £1750.

Forms and particulars (stamped, addressed envelope) obtainable from Clerk to the Governors, Education Offices, Cobourg Street, Plymouth, to whom they should be returned by 10th May, 1960. E9575

UNIVERSITY OF DUBLIN

TRINITY COLLEGE

RESEARCH STUDENTSHIP IN CIVIL ENGINEERING

Applications are invited for a RESEARCH STUDENTSHIP IN CIVIL ENGINEERING, value £500 per annum, for the two-year period beginning September 21, 1960. A candidate must be a University Graduate in Engineering and, if appointed, will be required to register as a research student.

Further information may be obtained from the Professor of Engineering, Trinity College, Dublin, who will receive applications until June 1st, 1960. E9574

H.M. DOCKYARD TECHNICAL COLLEGES

ASSISTANT LECTURERS (GRADE A or B)

Pensionable (non-contributory) posts for men : two in Electrical Engineering (Portsmouth and Rosyth) ; one in Mechanical Engineering (Rosyth) ; one (Grade A only) in English with a modern language (Chatham). Ability to help with other subjects essential. Appointment as soon as possible, preferably by September, 1960. Qualifications : University degree or equivalent, and ability to teach special subject to H.N.C. standard. Final year students may apply. Burnham scales for Technical Colleges (no deduction for pension). Write Civil Service Commission, Burlington Gardens, London, W.1, for application form, quoting 5125/60. Closing date 12th May, 1960. E9539

CITY OF NOTTINGHAM

APPOINTMENT OF CITY ENGINEER AND SURVEYOR

Applications are invited from persons who have the necessary experience and qualifications for the appointment of CITY ENGINEER AND SURVEYOR, at a salary of £3340, rising by one increment of £115 and two further increments of £110 to £3675 per annum.

The gentleman appointed will be required to devote the whole of his time to the duties of the office and will not be permitted to hold any other appointment or engage in any other work.

The appointment carries superannuation and the selected applicant will be required to pass a medical examination and to contribute to the superannuation fund.

Applications, stating age, previous experience and present position, accompanied by two testimonials and the names of two persons to whom reference can be made, must be delivered to me not later than the last post on the 18th May, in an envelope endorsed "City Engineer."

T. J. OWEN,
Town Clerk.

The Guildhall,
Nottingham.

E9562

PUBLIC APPOINTMENTS

BRITISH TRANSPORT COMMISSION

RESEARCH DEPARTMENT OF BRITISH RAILWAYS

British Railways are expanding the scientific research staff in their laboratories at Derby, and have vacancies in the following grades :

(1) SCIENTIFIC OFFICERS, GRADE 1 : Maximum salary £1150 per annum for work on :

(a) Rolling stock, including the study of the riding of vehicles and the measurement and evaluation of dynamic stresses in them, performance of bearings, &c.

(b) Marshalling and the movement of wagons, transit and vibration shocks, the measurement and computation of design factors needed for mechanised yards.

(c) Electronics—providing instruments needed in the above fields ; a sound understanding of electrical fundamentals essential, together with a knowledge of modern measuring techniques.

Candidates for the above positions must have a good Degree and/or professional qualifications, and have previous experience in engineering or research.

(2) SCIENTIFIC OFFICERS, GRADE 2 : Salary £698 per annum rising to £1034 per annum, depending on previous experience, for work on :

(a) The assessment of the strength of bridges and structures, including measurements of dynamic and static stresses.

(b) The development of vacuum braking systems, studies of air flow over vehicles and structures, including some Wind Tunnel work.

Candidates for these positions must have a good Degree, but previous experience in research is not essential.

(3) SENIOR TECHNICAL ASSISTANTS : Salary range £875 per annum rising to £1034 per annum for work in most of the fields previously mentioned, but including work on permanent way problems such as long welded lengths, rail stresses, formation loading, &c.

Candidates must be in possession of the Higher National Certificate, with appropriate engineering training, preferably with Graduate membership of one of the leading Engineering Institutions. Some experience of experimental procedure an advantage.

All applicants will be in competition with Railway staff, and must pass the Railway Medical Officer if selected for one of these posts. Selected applicants will be eligible for membership of the Superannuation Fund, and to certain travel facilities, after serving a probationary period.

Applications to be sent to :
Director of Research (British Railways),
British Transport Commission,
222 Marylebone Road,
London, N.W.1. E9545

CIVIL SERVICE COMMISSION

CIVIL, STRUCTURAL AND PUBLIC HEALTH ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service and temporary Government service as Civil, Structural, or Public Health Engineer). Candidates must have achieved Corporate membership of an appropriate professional Institution or have passed examinations necessary for attaining such membership. Some posts require qualifications in certain subjects. Starting salary (men, London) from £830 to £1125, according to age. Scale maximum (London) £1300. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/64-66/8. E9538

EAST AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION

ASSISTANT MECHANICAL ENGINEER

Pensionable appointment. Salary : £1170-£1755. Free passages. Free furnished quarters for first tour ; thereafter furniture rental is payable.

Candidates, 25-35 years, must have passed or be exempt from Parts I and II of the examination of the Institution of Mechanical Engineers and have served an apprenticeship with a British railway or a firm of locomotive or diesel engine builders, followed by at least 4 years' practical experience in the Mechanical Department of such an undertaking.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 173/06/D4. E9570

Classified Advts. continued on page 126

PUBLIC APPOINTMENTS

NORTH EAST DERBYSHIRE JOINT WATER COMMITTEE

TECHNICAL STAFF

Applications are invited for the following appointment on the staff of the Engineer and Manager.

The commencing salary will be in accordance with qualifications and experience.

The appointment offers good experience in waterworks design and construction.

SENIOR ASSISTANT ENGINEER
(A.P.T. Grade IV : £1065–£1220.)

Applicants must be Corporate Members of the Institution of Civil Engineers and they should have had previous experience in the design and construction of service reservoirs, treatment plants and pumping stations.

Housing accommodation will be made available to the successful applicants and a car allowance will be paid up to 8 h.p. in accordance with the National Scale.

The post is superannuable and the successful applicant will be required to pass a medical examination.

Applications, stating age, qualifications, experience and appointments held, together with the names of two referees, should be submitted to the undersigned not later than 14th May, 1960.

H. O. HAWKINS,
Clerk.
Rural Council House,
Saltergate,
Chesterfield. E9571

KINGSTON GROUP HOSPITAL MANAGEMENT COMMITTEE

TWO ASSISTANT ENGINEERS

Applications are invited for the appointment of TWO ASSISTANT ENGINEERS (one to assist the Senior Engineer in supervising the engineering services of Kingston Hospital, and the other to be in charge of the Engineering Department of the Royal Hospital, Richmond), from candidates who have completed an apprenticeship in mechanical engineering and have experience, preferably in a hospital, of the principles and practice of the efficient operation of steam and oil-fired boiler plants. Ordinary National Certificate in Mechanical Engineering desirable. Good residential quarters available. Pension scheme in force.

Salary scale : £575 by £25 (5) to £700 per annum, plus London Weighting (commencing point according to previous experience.

Apply, with details of age, qualifications and previous experience, with names of two referees, to Group Secretary, Kingston Group Hospital Management Committee, 35, Coombe Road, Kingston-upon-Thames, Surrey. E9563

SURREY COUNTY COUNCIL

HIGHWAYS AND BRIDGES DEPARTMENT

Highways and Bridges Department have vacancies for :

(a) QUALIFIED CIVIL ENGINEERS experienced in modern methods of design and construction of roads and bridges. Duties will include the design of major road improvements, including two-level junctions.

(b) ENGINEERING ASSISTANTS. Appointments provide suitable experience for those proceeding to a professional qualification.

SALARY RANGES for :

(a) Between £785 and £1375 per annum, and
(b) Between £610 and £1065 per annum,

plus London Allowance.

Particulars and forms of application, returnable by 14th May, 1960, from County Engineer, County Hall, Kingston-upon-Thames. E9664

WEST KENT MAIN SEWERAGE BOARD

JUNIOR ENGINEERING ASSISTANTS

Two JUNIOR ENGINEERING ASSISTANTS required, in A.P.T. I (£610–£765 per annum, plus London weighting). Experience of general engineering drawing-office practice is essential. Local Government superannuation.

The Board's District covers 172 square miles ; the population exceeds 600,000. Current work includes new main sewers in tunnel and the design and construction of new purification works.

Applications, with full personal details, particulars of education, training and experience, and the names and addresses of two referees, to William Howard, B.Sc., M.I.C.E., Engineer to the Board, within ten days of publication of this advertisement.

A. J. W. JEFFERY,
Secretary of the Board.
20, Blyth Road,
Bromley, Kent. E9544

THURROCK URBAN DISTRICT COUNCIL

TWO ASSISTANT ENGINEERS

Thurrock Urban District Council (population 107 100 increasing) (Engineer and Surveyor's Department) require TWO ASSISTANT ENGINEERS. Salary, A.P.T. IV : £1065 to £1220 p.a. Applicants should be Chartered Civil or Municipal Engineers, or have equivalent qualifications, and have extensive civil engineering experience and be capable of designing and supervising construction of major schemes. In particular, experience is desired in sewerage and sewage disposal and/or bridges and roads. Housing accommodation may be considered if successful candidates reside more than 20 miles from Thurrock. Appointment pensionable. Applications, stating age, qualifications, and experience, and quoting three referees to the Clerk of the Council, Council Offices, Grays, Essex, by 26th April 1960. Canvassing disqualifies. Relationship with Members or Senior Officers of the Council must be disclosed. E9510

PUBLIC APPOINTMENTS

SCIENTIFIC CIVIL SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

The Scientific Civil Service needs men and women for pensionable posts as (a) SENIOR SCIENTIFIC OFFICERS and (b) SCIENTIFIC OFFICERS in all major scientific fields, including PHYSICS, CHEMISTRY, METEOROLOGY, MATHEMATICS and BIOLOGY. Some particular vacancies include :

PHYSICISTS/ELECTRICAL ENGINEERS for research in the application of servo-control for machine tools.

PHYSICAL CHEMISTS.

CHEMISTS for research in high polymers.

BOTANIST for study of bryophyta.

PHYSIOLOGIST for work at the Institute of Aviation Medicine.

PALAEONTOLOGISTS to specialise in Palaeobotany and for work on Fossil Mollusca.

MINERALOGIST to work on Meteorites (Petrologist with sound knowledge of Physics preferred).

ZOOLOGISTS to specialise in the taxonomy of the Porifera and in Serological and other histochemical techniques applicable in Zoology and Anthropology.

Qualifications : normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment ; additionally, for (a) at least 3 years' relevant (e.g. post-graduate) experience. Normal age limits : (a) between 26 and 32 ; (b) between 21 and 29, with extension for regular Forces Service and Overseas Civil Service. London salaries (men) : (a) £1233 to £1460 ; (b) £655 to £1150 ; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting (a) S/53/60 ; (b) S/52/60. E9540

AIR MINISTRY

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

Air Ministry require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS, for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary : £805 at 25 to £1095 at 34 or over, thereafter rising to maximum £1260, with increase for London and slight decrease for country districts. Appointments non-pensionable but long-term. Promotion prospects 5-day week with 4 weeks 2 days leave a year initially. Special allowance in addition to salary during overseas service.

Qualifications and experience :

(i) (a) University Degree or equivalent Diploma in Electrical and/or Mechanical Engineering with at least 2 years' apprenticeship ; or
(b) Graduate or Corporate Member of I.E.E., with at least 3 years' apprenticeship ; or
(c) Graduate or Corporate Member of I.Mech.E., appreciable electrical engineering experience, with at least 3 years' apprenticeship ; and

(ii) Have been employed for minimum of 2 years with well-established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects, between ages of 25 and 45.

Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.158/OA. E9142

BECHUANALAND PROTECTORATE

PUBLIC WORKS DEPARTMENT

ENGINEER (MECHANICAL)

To assist the Senior Engineer (Mechanical) in the running of the Government Workshops, transport and mechanical equipment.

Permanent or contract/gratuity appointment. Salary in range £928 to £1848. Rented quarters. Free passages. Children's education allowance.

Candidates must be A.M.I.Mech.E. or possess B.Sc. in mechanical engineering with at least 5 years' relevant experience.

Write Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/76/013/D4. E9527

CENTRAL ELECTRICITY GENERATING BOARD

EASTERN DIVISION

3RD ASSISTANT ENGINEER (CIVIL AND MECHANICAL)

Applications are invited for the following appointment :

3RD ASSISTANT ENGINEER (CIVIL AND MECHANICAL), Divisional Electrical Department (Design and Construction Section), Divisional Headquarters—Cockfosters.

Salary : N.J.B. Class AX/DX, Grade 5, £1090 by £25 to £1215/£1320 per annum, plus London Weighting.

The successful applicant will be required to supervise contractors in the construction of civil engineering works for transmission substations.

Applicants should have received training in civil and/or mechanical engineering and have experience in the construction of substations, and should preferably intend to qualify for Associate Membership of one of the Institutions of Civil, Mechanical or Electrical Engineers.

Experience in the construction of transmission lines on steel towers would be an advantage.

Apply by 7th May, 1960, quoting Staff Vacancy No. 1319, giving age, details of qualifications and experience, to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts. E9573

PUBLIC APPOINTMENTS

GOVERNMENT OF BRITISH GUIANA

PUBLIC WORKS DEPARTMENT

MECHANICAL ENGINEER

To maintain all Public Works Department equipment, including road-making equipment and sea and river defence machinery.

Contract appointment. Salary in the range £1100–£1400 per annum. Gratuity 22½ per cent of salary. Free passages.

Candidates must be A.M.I.Mech.E. or Grad. I.Mech.E., or exempt from Parts I and II of the Institutions' examination with at least five years relevant experience.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD112/30/011/D4. E9579

ROYAL NAVAL COLLEGE, GREENWICH

Assistant Professorship of Applied Mechanics

Applications are invited from men aged at least 31 on 1st January, 1960, with high academic qualifications in Engineering, and teaching and research or industrial experience. Advanced knowledge of structural design and strength of materials, and good mathematical ability are desirable.

The duties will include lecturing, design of experiments, and supervision of student research in specialised fields, e.g. dynamics of machinery, mechanical vibration, fluid mechanics, mechanical control systems. Research facilities are available. The successful applicant should be available to take up appointment in January, 1961, or earlier. Secondment from the Scientific Civil Service considered. Salary £2400 to £2700. Starting salary may be above minimum. Single accommodation may be provided. Application forms may be obtained from Civil Service Commission, 17, North Audley Street, London, W.1, quoting S/5128/60, and should be returned by 17th May, 1960. E9536

TENDERS

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

REF. No. 18177/59/BMB/HAL.

TWIN SPINDLE, TWO-WAY, SPECIAL BORING MACHINE with Hydraulic Saddles and drives for Integral Coach Factory.

The Tender forms with schedules and specifications, which are returnable on 26th May, 1960, may be obtained from the above Office (C.D.N. Branch) on payment of a fee of 10s. (not refundable) for each Tender.

The applications for Tenders should clearly state the above reference. E9530

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

REF. No. 18173/59/BMB/HAL.

HORIZONTAL BORING AND MILLING MACHINE and VERTICAL CO-ORDINATE BORING MILL with Optical Setting System.

The Tender forms with schedules and specifications, which are returnable on 26th May, 1960, may be obtained from the above Office (C.D.N. Branch) on payment of a fee of 10s. (not refundable) for each Tender.

The applications for Tenders should clearly state the above reference. E9531

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

REF. No. 18174/59/BMB/HAL.

99 PER CENT. PURE ALUMINIUM INGOTS (63 tons), and 98·5 PER CENT. PURE SILICON (10 tons).

The Tender forms with schedules and specifications, which are returnable on 26th May, 1960, may be obtained from the above Office (C.D.N. Branch) on payment of a fee of 10s. (not returnable) for each Tender.

The applications for Tenders should clearly state the above reference. E9532

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

REF. No. 18168/59/BMB/HAL.

TWO-COLUMN PLANER, 4000 m./m. by 1250 m./m. by 850 m./m., with one head on cross rail and two side heads, and one grinding head on cross rail.

The Tender forms with schedules and specifications, which are returnable on 26th May, 1960, may be obtained from the above Office (C.D.N. Branch) on payment of a fee of 10s. (not refundable) for each Tender.

The applications for Tenders should clearly state the above reference. E9528

TENDERS

INDIA SUPPLY MISSION

The Office of the India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, invites TENDERS for the following :

(a) TENDER ENQUIRY No. SE.163
For the SUPPLY of BOURDEN GAUGE and MASTER GAUGE required by Uttar Pradesh Irrigation Research Institute, Roorkee, India.

(b) TENDER ENQUIRY No. SE.119/REIN
For the SUPPLY of a HYDROGEN GAS GENERATOR, capable of delivering 50 cubic feet. Required by Hindustan Antibiotics, India.

(c) TENDER ENQUIRY No. S.E.122/REIN
For the SUPPLY of SUBMERGED COIL TYPE AMMONIA COOLER to cool brine in a tank to 20 deg. Fah. unit to be rated 12 5 tons refrigeration. Required by Hindustan Antibiotics, India.

(d) TENDER ENQUIRY No. S.E.162
For the SUPPLY of 15 SETS 300/400 g.p.m., 300/250 feet Head ELECTRICAL SUBMERSIBLE PUMPING SETS. Required by Neyveli Lignite Corporation Ltd., Madras, India.

Specifications, etc., relative to the above specifications can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of 14 shillings and 3 pence per Tender enquiry, and is not refundable.

Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W., Washington 8, D.C., United States of America, so as to reach them by (a) 24th May, 1960 ; (b) 26th May, 1960 ; (c) 19th May, 1960 ; and (d) 9th June, 1960.

Specimen copy of the above enquiries can be seen at Engineering Branch, India Stores Department, Bromyard Avenue, Acton, W.3, under the following references : (a) S.3011/60/NSC/ENG.2 ; (b) S.3012/60/NSC/ENG.2 ; (c) S.3013/60/NSC/ENG.2 ; (d) S.4278/59/NSC/ENG.2. E9554

GOVERNMENT OF THE GAMBIA

PUBLIC WORKS DEPARTMENT

BARRA FERRY TERMINAL

TENDERS are invited from experienced Contractors for the CONSTRUCTION of a FERRY TERMINAL at Barra, on the North bank of the estuary of the Gambia River.

The works consist of a piled access jetty approximately 10'0 feet long in reinforced concrete, a solid berthing head, incorporating a vehicle landing ramp, and shore ancillaries.

Copies of the Tender documents and drawings, to be issued as from 25th April, 1960, may be obtained from the Consulting Engineers, Messrs. G. Maunsell and Partners, 66, Haymarket, Westminster, London, S.W.1. Applications must be accompanied by a deposit of £10 which will be refunded on receipt of a bona fide Tender and the return of all Tender documents and drawings.

Tenders should be delivered simultaneously to the Major Tender Board, Bathurst, and a duplicate copy to the Consulting Engineers, Messrs. G. Maunsell and Partners 66, Haymarket, Westminster, London, S.W.1, not later than 6th June, 1960.

The lowest or any Tender will not necessarily be accepted. E9502

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :—

REF. No. 18157/59/BMB/HAL.

VERTICAL PRODUCTION MILLING MACHINE, area of table 1235 m./m. by 460 m./m., Milling Spindle Head tiltable vertically in both directions to 90 deg.

The Tender forms with schedules and specifications, which are returnable on 26th May, 1960, may be obtained from the above Office (C.D.N. Branch) on payment of a fee of 10s. (not refundable) for each Tender.

The applications for Tenders should clearly state the above reference. E9529

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN CONTROL ENGINEERING, 1960-1961

Applications are invited for the ONE-YEAR COURSE IN CONTROL ENGINEERING which begins on 10th October, 1960. Prospective students must be of Graduate status in an appropriate branch of Science or Engineering, or have attended a preliminary one-year course at the College and, preferably, have had practical experience.

The purpose of the Course is to give instruction in the techniques employed in control engineering as applied in a wide range of industries.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from : The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E9261 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. **Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques.** Approximately **95 per cent. successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8.** E114 E

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN FLIGHT CONTROL, 1960-1961

Applications are invited for the ONE-YEAR COURSE IN FLIGHT CONTROL which begins on 10th October, 1960. Prospective students must be of Graduate status in an appropriate branch of Science or Engineering, or have attended a preliminary one-year course at the College and, preferably, have had practical experience.

The purpose of the Course is to give instruction in the techniques employed in the automatic control of all types of flying machine.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from : The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E9262 t

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

ASSISTANT CHIEF MAINTENANCE ENGINEER required by a large Steelworks in the Midlands. The position is a senior one offering prospects of advancement for a qualified Engineer experienced in the control of labour. A good practical knowledge of heavy plant and associated mechanical and civil services is required. Contributory pension and Free Life Assurance Schemes.—Please send full details of age, qualifications, experience, and salary required to BOX No. E9552, " The Engineer." A

B.B.C. requires ENGINEER in London, for design work on equipment associated with sound recording and reproduction on disc, magnetic tape and film. Applicants (British) should preferably hold Degree or equivalent in Mechanical Engineering, with experience in design of light mechanisms for small-scale batch production. Some knowledge of audio-frequency electronics essential and acquaintance with sound recording techniques desirable. Salary in scale £1230, with annual increments to maximum of £1580 per annum.—Requests for application forms to Engineering Recruitment Officer, Broadcasting House, London, W.1, quoting ref. 60 E.39 Eng. E9535 A

DESIGNER, with practical experience or rubber-to-metal pumps to assist with further development of successful range of pumps. Must have at least H.N.C. or equivalent and knowledge of elastomers and rubber-to-metal bonding. Salary in the range of £1100 according to experience. Good superannuation scheme.—BOX No. E9580, " The Engineer." A

SITUATIONS VACANT

BRITISH OXYGEN GASES LTD.

are anxious to strengthen their

OUTSIDE REPRESENTATION

in the inert gas shielded welding field. Applicants should be under 28 years of age, preferably single and be prepared to live anywhere in the British Isles. They should be of G.C.E. educational standard, and possess some specific electrical knowledge. An engineering background and experience of inert gas welding would be an advantage.

Write, stating full details to
Personnel Manager,
British Oxygen Gases Ltd.,
Spencer House, St. James's Place,
London, S.W.1.

E9569 A

DESIGN ENGINEERS

required for work on the design of large modern Water-tube Boiler Plant, involving problems in combustion engineering, heat transfer and fluid flow. Experience in one or more of these fields is a necessary qualification, and an Engineering Degree would be an advantage but is not essential.

Full particulars, stating age, qualifications and past experience, should be sent to :
Chief Design Engineer,
John Brown Land Boilers, Ltd.,
Whitecrook Works,
Clydebank.

E2804 A

DRAUGHTSMAN, widely experienced in design of special and standard steel shuttering and allied builders' equipment. Concrete mould experience an advantage. Holiday arrangements honoured. Write, giving full details of experience and qualifications.—BOX No. E2803, " The Engineer." A

DRAUGHTSMEN.—Four required by Tyneside Power Station Contractors, able to work with minimum supervision and having experience in either (a) Electrical Diagrams, Cable Layouts or Signalling. (b) Plant Layouts, Steam and Feed Pipework, &c., or (c) Structural Steel and/or Reinforced Concrete. Write fully in first instance to Chief Draughtsman.—BOX No. E2998, " The Engineer." A

SITUATIONS VACANT

ENGINEER, with H.N.C. or equivalent, and preferably with basic electrical knowledge, to undertake interesting experimental work on Mechanical and Heat Transfer Tests in Research and Development Department.—Reply, stating age, qualifications and salary required to Personnel Manager, The Superheater Co., Ltd., Ashburton Road, Trafford Park, Manchester, 17. E9215 A

ENGINEER, fully qualified, required by Independent Lubricating Oil Manufacturers, North of England. Age 30-40. Duties include technical assistance to sales, plant surveys, development. Must have diesel experience. Progressive position for applicant with initiative. Contributory pension scheme.—Write full particulars of experience, qualifications and salary required to BOX No. E2810, " The Engineer." A

ENGINEER-DESIGNER urgently required for interesting work in the production of Aluminium and/or novel Material Tanks for transport and airfield fuelling operations. Good salary and pensions scheme.—BOX No. E9568, " The Engineer." A

ENGINEERING, PHYSICS AND SCIENCE GRADUATES OR EQUIVALENTS required for new appointments involving research, design and development work on :

(1) Machining processes ; initially work will be concerned with the appraisal of new machining developments.
(2) Mechanical engineering equipment including special machine tools, presses, mechanisms, test rigs, etc.

Successful candidates will be expected to take complete responsibility for projects from conception to completion. Capacity for creative thinking and initiative are important. The conditions of employment are attractive. Superannuation scheme. Removal expenses paid.—Send full details in confidence to the Secretary (R.671), Production Engineering Research Association, Melton Mowbray, Leics. E9576 A

FACTORY MANAGEMENT EXECUTIVE

Gentlemen trained and experienced in the maintenance of large Factories and Labour Control, will shortly be required as ASSISTANT to Works Superintendent controlling group of factories in North of England city.

Candidates for this position, who should be in age group 33 to 40, are asked to include in their applications full details of training, past experience also of positions held, and should at present be in receipt of not less than £1500 per annum.

The position is superannuable.

Letters received will be treated with the utmost confidence.—Write BOX No. E9581, " The Engineer." A

INSTRUMENT ENGINEERS.—Simon-Carves, Limited, require Instrument Engineers for employment in U.K. and overseas. Experience of instrumentation of chemical/refinery installations desirable. Men with works training and holding O.N.C. or H.N.C. are preferred. Please forward full details of age, experience and qualifications and quoting Ref. SC.36, to Contract Labour Department, Simon-Carves, Limited, Stockport. E9499 A

LANCASHIRE TAR DISTILLERS require a DRAUGHTSMAN for their Engineering Department.

Applicants should be at least 23 years of age, with experience in chemical plant, pipework, &c., and should preferably be of H.N.C. standard.

Superannuation scheme, canteen.

Applications, in confidence, giving age, qualifications and experience to Chief Engineer, Lancashire Tar Distillers Ltd., Liverpool Road, Cadishead, Nr. Manchester.

E9475 A

METHODS ENGINEER

required for a Group of Companies in the Sheffield Area. The position offers immense scope for a young man between 25-35 years of age having suitable qualifications and experience of modern production techniques. He would be concerned mostly with the manufacture of finished products from steel and plastics, and therefore good general engineering knowledge essential.—Please state age, experience and salary required to BOX No. E2809, " The Engineer." A

PROJECT ENGINEER

A Project Engineer is needed for a team of development engineers engaged on lifting and handling equipment design. The applicant must have modern design experience in welded steel structures, together with some practical experience of welding problems. A good salary is offered to the right man and the post is pensionable and permanent, located near Manchester.—Apply to BOX No. E9555, " The Engineer." A

SALES MANAGER.—The Bronx Engineering Co. Ltd., Lye, Worcestershire, requires a Sales Manager to cover Press Brakes for metal working. Knowledge of Press Brakes an advantage but not essential. This is a position for a senior man wishing to join an expanding Company, and the salary offered will be really attractive. E9553 A

SENIOR ENGINEER with knowledge and previous experience in the design of evaporative water coolers for industrial applications, required by progressive company, located 15 miles south of London. Holiday arrangements accepted.—Write, stating age, qualifications, previous experience, salary required to BOX No. E9570, " The Engineer." A

SITUATIONS VACANT

PROJECT ENGINEER

George Angus and Company Limited wish to appoint to their Management Staff a QUALIFIED ENGINEER with a production or general engineering background and knowledge of TEXTILE/PLASTICS/RUBBER manufacture.

He will be responsible for advising on new projects and for setting up departments to manufacture products outside our present range. This will involve purchase and layout of plant and training of operatives. Assistance from other department heads will be available, but the Project Engineer will be expected to take the initiative and to co-ordinate activities concerning the manufacture of new products.

This is a new appointment offering good prospects of advancement in an expanding Group to an Engineer (age 30 to 40) who has ability to get things done through people, and who wishes to broaden his experience of management problems. Initial salary in the range £1500-£1850 ; usual fringe benefits.

Please address applications to Appointments Officer, George Angus & Co. Ltd., Angus House, 152-158 Westgate Road, Newcastle upon Tyne, 1.

E9560 A

STAFF FOREMAN required by Large Excavator Manufacturing Firm of about 3000 employees. Applicants must have served a plater apprenticeship and have experience in light gauge structural plating work. The successful candidate will be required to take eventual charge of a department of some 80 employees engaged in the manufacture of cabs, gear cases and fuel tanks for excavators, with additional responsibilities for welding.—Applications in writing, giving all relevant particulars, that is, experience, education and approximate salary, to the Industrial Relations Department, Ruston-Bucyrus, Ltd., Excavator Works, Lincoln. E9549 A

TECALEMIT, LIMITED, PLYMOUTH, DEVON

have a vacancy for a LABORATORY ASSISTANT in the Physical Laboratory of the Research Department.

The work involves research and control on non-metallic materials such as filter media, plastics, rubber and adhesives.

Applicants should have a University degree in Mechanical Engineering or equivalent qualification with an interest in physics or technology ; research experience with one of the materials mentioned and some experience in statistics as applied to planning and evaluating experimental work will be an advantage.

The finally selected candidate will find interesting and varied work in a progressive and active modern factory. His salary will be commensurate with his qualifications and experience.

The Company operates a contributory superannuation and life insurance scheme.

Applications should include details of age, education and experience, and be addressed to the Employment Officer.

E9459 A

VOSPER LIMITED, PORTSMOUTH

require a young (25-35) SERVICE ENGINEER for their roll damping division (Ship Stabilisers).

Work will involve the supervision of installations at home and abroad, carrying out trials and subsequent servicing.

The appointment will involve travelling world-wide.

Good salary, holidays, pension scheme, etc. Good prospects for right man.

Write in first instance giving particulars of experience, age, salary required, to the Secretary, Vosper Limited,
P.O. Box 18, Portsmouth.

E9572 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, " The Engineer." A

YOUNG CHEMIST or ENGINEER required, to visit laboratories in Great Britain in demonstration van, for technical sales promotion of Laboratory Heaters.—Please apply, stating past experience, to Isopad Limited, Boreham Wood, Herts. E9534 A

Presentation of Technical Information

GKN

The Group Research Laboratory offers an interesting post in its Liaison and Information Division to a young man with some experience in technical journalism.

The successful applicant will be responsible for editing a technical journal, and for writing and producing a 6-monthly progress report on the work of the Laboratory. Both publications are distributed throughout the Group, which consists of over 80 companies engaged in steelmaking and many forms of engineering.

Some technical knowledge and the ability to present technical information in an interesting and understandable form are essential.

Applications, giving details of qualifications, age, experience, etc., should be addressed to :
The Recruitment Officer,
G.K.N. Group Research Laboratory,
Birmingham New Road,
Lanesfield,
Wolverhampton.

E9533 A

Classified Advts. continued on page 128

BOOKS and PUBLICATIONS

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R. M. CURRIE. A complete authoritative exposition of the subject for students—techniques, the historical background, purposes and functions, value to management. An excellent textbook. 22/6 *net*.

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SITUATIONS VACANT

OVERSEAS APPOINTMENTS

SIMON-CARVES, LIMITED,

require

MECHANICAL ENGINEERS

FOR OVERSEAS CONTRACTS

Applications are invited from men between 30 and 40 years of age who have experience in the erection and installation of electrical and heavy mechanical engineering plant, including H.P. compressors, pipelines and vessels. A.M.I.Mech.E. or similar qualification desirable.

Applications, quoting Ref. No. 31 with details of age, experience and qualifications, should be forwarded to Contract Labour Dept., Simon-Carves, Ltd., Cheadle Heath, Stockport.

E9500 A

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY LIMITED GOVAN, GLASGOW

Invite applications for the following position :

HEAD FOREMAN

to take charge of Gearing Department. Applicants should have a wide experience in the production of High Accuracy Marine Reduction Gearing.

Applications for the above position will be treated as confidential, and should be addressed to the Company stating age, qualifications and experience.

No references are required in the first instance.

The successful applicant will be expected to join the Company's pension scheme.

E9496 A

SENIOR DRAUGHTSMEN

for old-established company specialising in bulk mechanical handling machinery and modern foundry mechanisation. Progressive well-paid and permanent jobs for right men. Five-day week, 3 weeks annual holiday, luncheon vouchers. (Holiday arrangements honoured.)

Apply :

Personnel Director,
MARCO CONVEYOR & ENGINEERING CO. LTD.,
Lynn Road, Leytonstone,
London, E.11.
LEY 2254.

E9493 A

SITUATIONS VACANT

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and the DEVELOPMENT AND ENGINEERING GROUP
of the UNITED KINGDOM ATOMIC ENERGY AUTHORITY

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Graduate apprenticeships are available for Engineers and Chemical Engineers. Salaries will be in the range £550–£1,185 with prospects of promotion to more senior posts before the maximum of the scale is reached. All appointments are permanent and pensionable.

Vacancies exist at the following establishments

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WINDSCALE AND CALDER
Sellafield, Cumberland

Groups representatives visit Universities from time to time. If you are interested in a career with the U.K.A.E.A. please get in touch with your Appointments Board Secretary or write direct to:

Senior Recruitment Officer,
UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
Risley, Warrington, Lancs.

E9547 A

PROFESSIONAL ENGINEER

is required at the

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE, HARWELL, BERKS.

An EXCELLENT CAREER OPPORTUNITY exists for a Professional Engineer to :

- ★ LEAD the Engineering Safety Section of the Rutherford High Energy Laboratory.
- ★ ADVISE on engineering and operating safety in large laboratories and supporting workshops.
- ★ ANALYSE CRITICALLY design of pressure and vacuum vessels, chemical equipment and electrical circuitry.
- ★ ORGANISE safety inspection of lifting appliances and inflammable materials.

SALARY : £1345 to £1800 p.a.

Experience of safety engineering in a large experimental or development organisation an advantage.

Housing and Superannuation Schemes.

Please send POST CARD for details to The Group Recruitment Officer (1661/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E9546 A

MECHANICAL ENGINEER

A large national Company has a vacancy for a Mechanical Engineer in each of the following centres :

Newcastle
Glasgow
Manchester
Wolverhampton

The Company is an expanding one and future prospects are very bright. The need is for good calibre men aged 28-30 with experience in the heavy engineering or chemical fields. Candidates should preferably have at least an H.N.C. in Mechanical Engineering, or M.O.T. 1st Class Certificate (Steam and Diesel) supported by an engineering apprenticeship. Please send brief details to BOX No. E9526, "The Engineer."

A

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required in established Development Department handling design and installation of a wide variety of plant for carbon black manufacture. Experience of this particular industry not required.

This appointment will be attractive to Draughtsmen seeking opportunities to accept responsibility and obtain advancement with a young and expanding Company.

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E9566 A

MECHANICAL ENGINEER

required in established Development Department handling design and installation of a wide variety of plant for carbon black manufacture. Experience of this particular industry not required.

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E9567 A

ICI GENERAL CHEMICALS DIVISION

has vacancies for GRADUATE ENGINEERS to work in sections applying :

(1) METHOD STUDY to chemical plant design, and

(2) WORK MEASUREMENT and method study to the operation of engineering workshops, including maintenance of a road tanker fleet, rail tank vehicles and diesel locomotives.

Applications are invited from men between the ages of 25 and 33 holding a good degree in engineering, and having had a few years' experience of any of these types of engineering. Previous experience of work study is not essential.

Although the men appointed to these vacancies might develop as specialists if they wished, there are frequent opportunities for men working in this field to transfer to other branches of the wide range of engineering activities required by the chemical industry.

Salary will be dependent on age and experience, and there is a Pension Fund and Profit-Sharing Scheme. Where necessary, married men will receive a refund of reasonable removal (including travel) expenses, and a temporary lodging allowance is payable whilst maintaining two homes.

Applicants should write (quoting reference GE21), stating age, qualifications and experience, to STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, GENERAL CHEMICALS DIVISION, CUNARD BUILDING, LIVERPOOL, 3.

E9560 A

SITUATIONS VACANT

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH AND DEVELOPMENT DEPARTMENT

LITTLEBROOK POWER STATION

PHYSICIST and MECHANICAL ENGINEERS required in the Applications Laboratory at Littlebrook Power Station, **Dartford, Kent.**

The successful candidates will join a team working on the development of an advanced steam cycle for power generation employing high temperature steam as the working fluid for a "gas "turbine" as proposed by J. F. Field (Proceedings, I.Mech.E., V.162, P.209, 1950 refer). This cycle could conceivably be operated with coal, oil or nuclear fuel, and provides an opportunity to gain experience in many aspects of power generation.

An experimental 1400 deg. F. steam superheater with a capacity of 100k.lb./hr. is already in operation and design study on a complete pilot plant has commenced.

(a) THE PHYSICIST should preferably have an honours degree and some experience in research work would be an advantage. The work in which he will be engaged would be mainly radiant and convective heat transfer, aerodynamics, and measurements connected with combustion problems.

(b) THE MECHANICAL ENGINEERS should preferably hold an honours degree and have some experience in Mechanical Engineering, and will be required to study problems involving one or more of the following :

The thermodynamics and aerodynamics of steam and gas turbines, and axial flow compressors. Steam cycle analysis. Radiant and convective heat transfer. High temperature metallurgy. General mechanical design.

Final year students who are interested in this project are invited to apply, with a view to joining the team on completion of their studies.

Salaries will be on a scale within a range rising to £1350 p.a., according to duties and responsibilities.

Applications concerning these appointments, which afford every prospect of advancement, should be made to the Personnel Officer, 24-30, Holborn, London, E.C.1, stating age, qualifications, experience, present position and salary as soon as possible. Envelopes should be marked "Confidential (ENR 140)."

E9541 A

ENGLISH ELECTRIC AVIATION LIMITED

GUIDED WEAPONS DIVISION

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Electronic · Servo · Mechanical

We are again increasing our engineering and design effort because of the expanding requirements of our major development projects.
We have the following important positions to fill in our guided weapons design and development organisation, one of the largest and most comprehensively equipped in Europe. The Company forms part of one of the largest engineering groups in the United Kingdom, and since the recent amalgamation, is also associated with one of the largest groups in the New Aircraft Industry.

We require—

ELECTRONIC AND SERVO ENGINEERS—to accept responsibility for the design of electrical, electronic and servo control equipment including airborne guidance equipment, ground control and launching equipment and test gear used for the proving of components, missiles and ground equipment.

MECHANICAL ENGINEERS—to work on the design and development of ground equipment, with such applications as launching systems, handling equipment and packaging.

ELECTRONIC AND MECHANICAL ENGINEERS—to work on Guided Weapon flight trials and to lead teams of technicians within the field trials unit.

Applicants should have a sound practical design background and be of H.N.C. standard.

ASSISTANCE WITH HOUSING AND REMOVAL EXPENSES MAY BE GIVEN.

These positions command progressive salaries as well as the amenities provided by a large Organisation.

Applications should be sent in confidence to :

Dr. D. A. Layne, c/o Dept. C.P.S., Marconi House, Strand, W.C.2, quoting reference E1396G.

E9559 A

Classified Advts. continued on page 130

SITUATIONS VACANT

BRITISH OXYGEN GASES, LTD.

have the following vacancies in their development group. The work is in connection with the development of equipment used in the medical field, for anæsthesia, oxygen therapy, resuscitation and automatic ventilation.

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Applicants should have a recognised technical qualification, preferably of pass degree or equivalent standard, as well as sound previous experience of design and development or experimental work in an appropriate direction. Familiarity with mechanical devices, scientific apparatus (not exclusively optical), instrumentation techniques, or systems involving the transfer of fluids would be an advantage.

TECHNICAL ASSISTANT

Applicants should possess an O.N.C. or equivalent, and have had some experience of test and experimental work of a nature parallel to that indicated above for the Development Engineer post.

APPLY IN WRITING TO PERSONNEL MANAGER,
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SPENCER HOUSE, 27, ST. JAMES'S PLACE, LONDON, S.W.1.

E9424 A

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Age; 35–50. Commencing salary not below £2,250. Contributory pension scheme.

Please send brief details in confidence, quoting reference G.2336, to D. J. Clarkson. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E134 A

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GRADUATE MECHANICAL ENGINEER, American, M.S.M.E. degree, 27, married, two years' experience, desires position with firm doing research and development work in internal combustion engines or fluid mechanics.—BOX No. E2808, "The Engineer." B

MISCELLANEOUS

TIME RECORDERS. Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157-159, Borough High Street, London, S.E.1. E110 I

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PATENTS

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E9550 G

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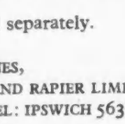

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200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
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May 10	**Machine tools and miscellaneous stores.**	M.O.A. Storage Depot, **Byley, Nr. Middlewich, Cheshire.** (Sale at Cheetham Town Hall, Manchester, 8.)	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
May 17-20	**Vehicles, earth moving and lifting equipment.**	M.O.A. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
May 24	**Miscellaneous stores.**	Command Ordnance Sub-Depot, **Devizes.** (Sale at Corn Exchange, Devizes.)	**FARRANT, WIGHTMAN & PINNIGAR** (Dept. L), 2, Newport Street, Swindon, Wilts. (Tel.: 5151/2.)
June 10	**Machine tools and miscellaneous stores.**	Technical Stores Depot, **Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
June 16	**Miscellaneous stores and Vehicles.**	M.O.A. Storage Depot, **Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.**	**DIXON & WALLACE, LTD.** (Dept. L), Bank Buildings, Graham Street Glasgow, E.1. (Tel.: Bridgeton 2447/9.)

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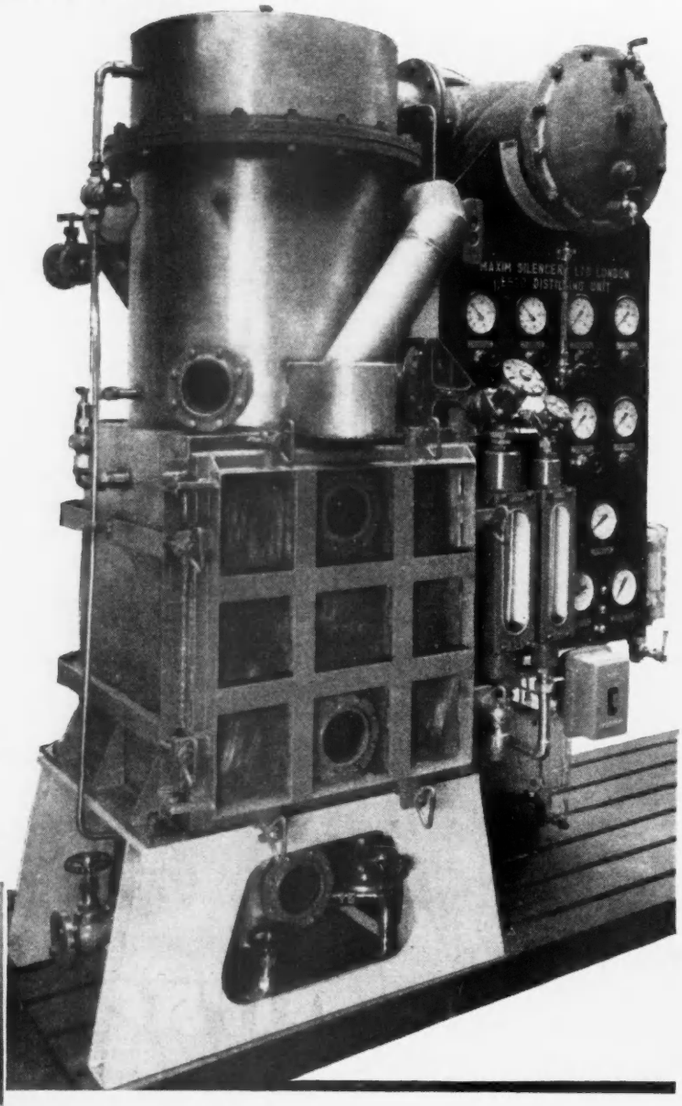

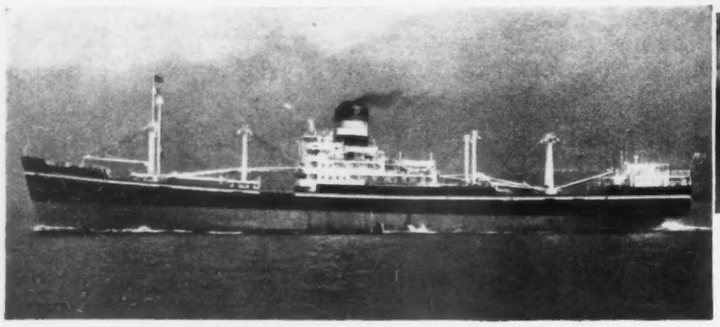

(Above) This Maxim L120D Unit gives an output of 37 tons of fresh water daily. Monel is used for the evaporator shell and the heating element to withstand boiling brine, waste steam heating and "cold shock" treatment.

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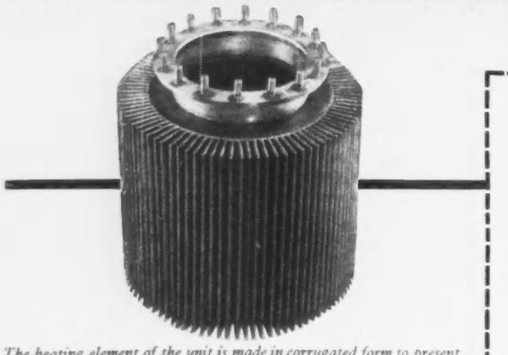

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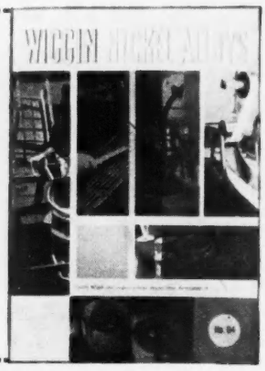

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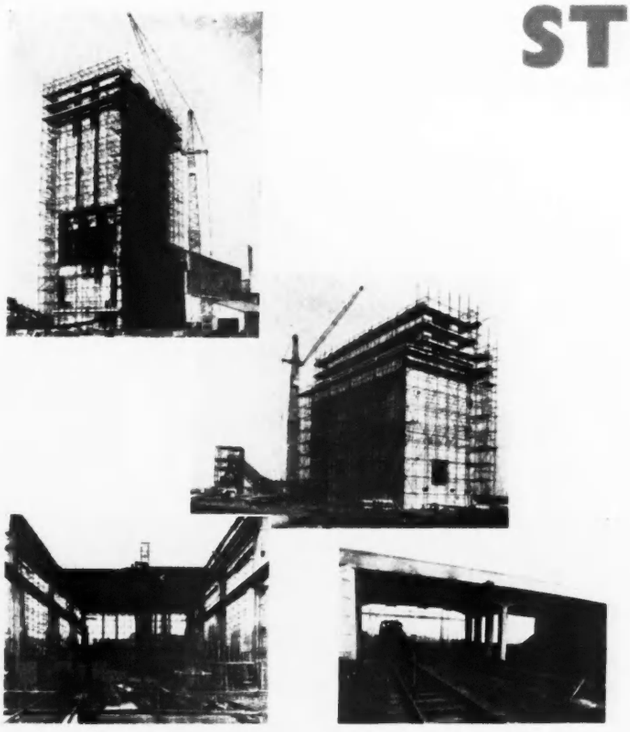

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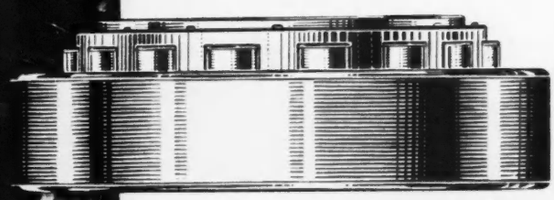

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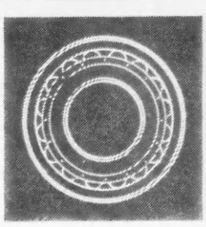

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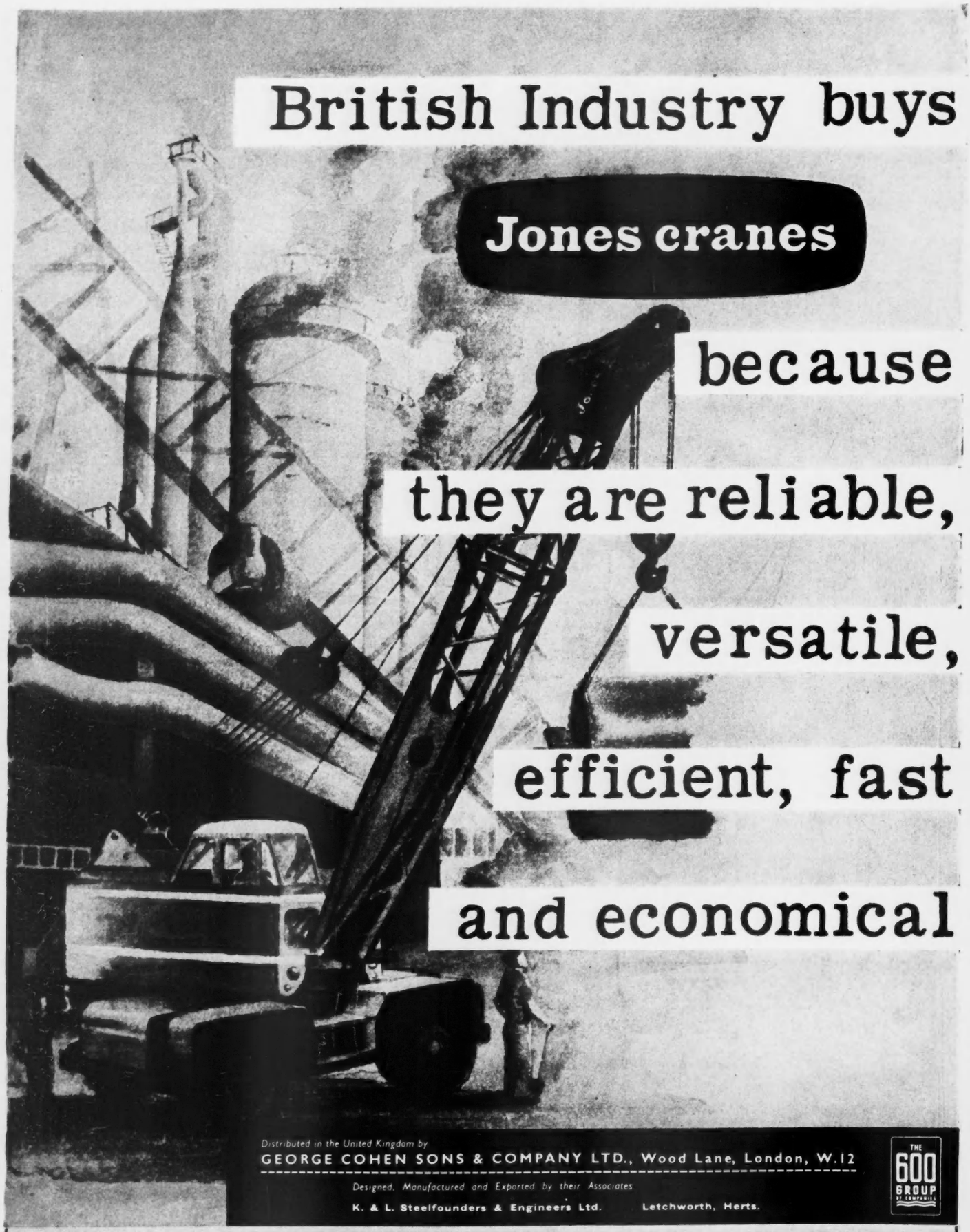
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